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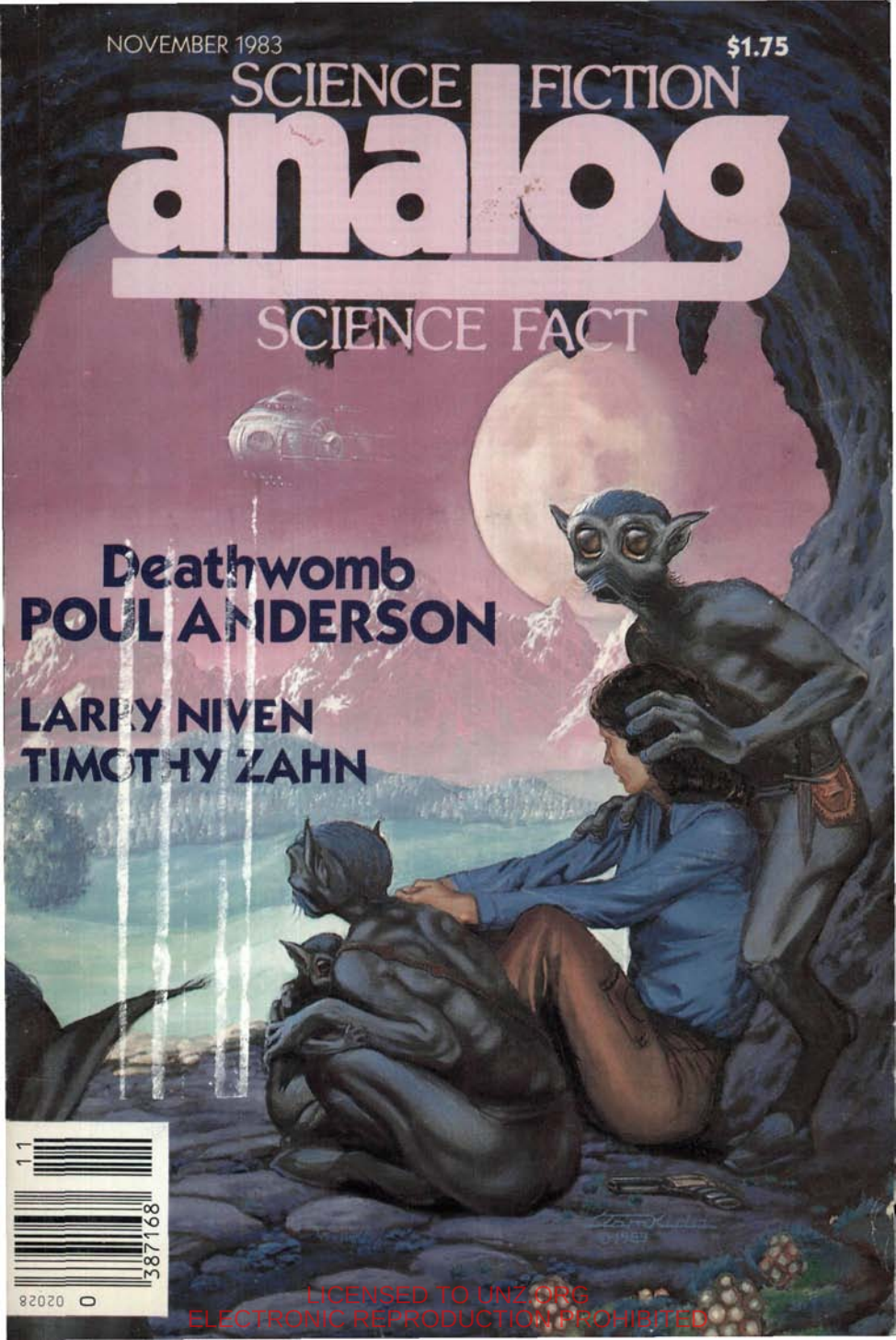

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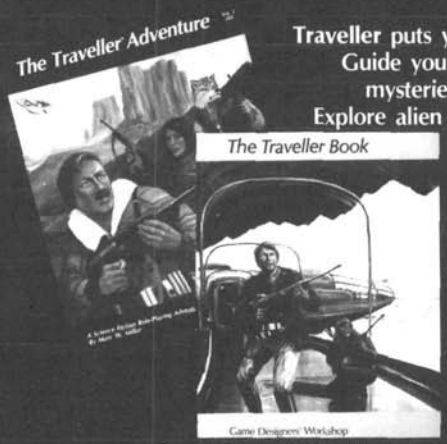

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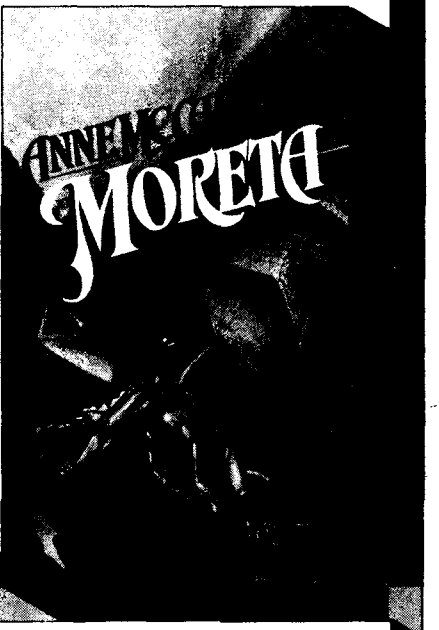

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Editorial

Stanley Schmidt

Fairly often in the last several years I've thought that this country could use a new Sputnik—not a primitive satellite, but a highly visible action by a country viewed as an enemy which might scare Americans into taking a good hard look at how well their educational systems are working. We still haven't got that, but we did recently get a substitute of sorts in the form of a report by the National Commission on Excellence in Education, calling urgently for massive educational reforms and citing as evidence of the need a wide range of data on literacy and test performance among American students. Washington has not shown much other than verbal activity on the matter (and there are probably advantages in that), but the report does

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seem to have stirred up a good deal of talk, some of which may eventually lead to action. Actually, the NCEE report may be only the tip of an iceberg, and there is some question as to how much it's a cause and how much an effect of a movement already underway. Some educators claim its description of the "rising tide of mediocrity" is several years out of date and many school systems have already begun measures to reverse the trend. Regardless of what is chicken and what egg, it's fairly clear that educational reform (or at least talk about it) is In (again).

The NCEE offered recommendations for action, none of them very surprising: stiffer graduation requirements and achievement standards, more time devoted to learning basics, better training and pay for teachers, increased citizen involvement. Other groups have gotten into the act with recommendations of their own, some of them with a commendably novel emphasis on demonstrable educational *results* rather than mere gestures of effort. The College Board, for example, has spelled out in some detail a set of skills which high school students should have before entering college. And the state of Florida has had the audacity (just upheld in court, even as I write this) to require that high school students pass a functional literacy test before being granted a diploma.

Everybody seems to agree that something is wrong and something needs to be done, but it might be well to get some precautions clearly in mind before plunging in. For one thing, change is not necessarily equivalent to improvement, and *any* proposed change deserves a good critical scrutiny before being adopted, to be sure it shows a reasonable chance of being more beneficial than otherwise. For another, education is a complex process involving so many collaborators that it's awfully easy—and tempting—for each group involved to assume somebody else is to blame for deficiencies.

Students blame teachers for being dull, incompetent, or prejudiced. Parents blame teachers for the same reasons plus low standards, and boards of education for failing to provide quality faculties, facilities, and programs. Boards blame parents for failing to vote adequate funds for these things. Teachers blame boards for policies, students for lack of motivation, other teachers for failing to prepare students adequately, and parents for failing to support education both financially and psychologically.

They're all right, to some extent.

And they're all wrong.

Let's take a slightly closer look at that Florida case. The state claimed it was requiring students to demonstrate that they have acquired and retained enough very basic reading and mathematical skills to be able to apply them to everyday situations such as shopping or reading medicine labels. The plaintiff claimed that the exam discriminated against black students. It's true that the failure rate has been higher among blacks than whites (though it has dropped dramatically since the test was started in 1977), but it does not necessarily follow that the test is discriminatory. I haven't seen a complete copy of the test, but if the

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samples I've seen are at all representative, I'd have to say that it does a pretty fair job of testing skills which are indeed really basic. If a student is unable to pass it, not much education has occurred. *Why* it has failed to occur with more black students than others is an entirely separate question from *whether* it has occurred. That statistical fact very probably reflects one or more educational problems that need to be solved (and apparently are being solved), but a high school diploma is not supposed to be a statistical measure of sociological problems. It is supposed to be a measure of what an *individual has learned* (*not* how many hours he has spent going through motions supposed to produce learning). As such, it should be given to anyone who can demonstrate the required degree of accomplishment, and denied to anyone who can't.

Period. Regardless of what excuses might be made for *why* an individual has not learned what he should have.

In principle, a final test of basic competence seems like a good idea, though I am well aware that real tests are never perfect. That doesn't mean it shouldn't be done, but only that great care needs to be taken to do it *well*. With no attempt at such a test, students can (and do) muddle through school and emerge with a paper that says they "know" a great many things which in fact they forgot as soon as they squeaked through the appropriate course. Knowledge which was stored so imperfectly that none is retained might as well never have been gained at all. The effect is the same, and that effect is of no value in later life.

The student who fails the test may blame the test, and the test may well be flawed. (But he does get *five* tries to pass it!) He may blame poor preparation, but how much of that is his teacher's responsibility and how much his own? His teachers may not have been very good, and that may be partly due to poor training, poor pay, and discriminatory districting—but how much responsibility for poor teaching can a teacher lay on these external influences and how much must he shoulder himself? School boards may say that the problem lies not with them because they can show receipts for large expenditures—but let's hope (perhaps futilely) they don't really believe that spending money is automatically equivalent to attacking problems. (As Ben Bova once remarked, "One of the best schools ever 'built' was a grove of olive trees with Socrates in it.") Educators and boards may agree that students are poorly motivated, and that may be partly the parents' fault—but a good enough teacher can go a long way toward overcoming even that. Ultimately, of course, the student is the one who benefits or suffers from his preparation or lack thereof. If he's smart, he'll insist on a good one and do everything in his power to get it, no matter how little help he gets from anyone else.

While I'm encouraged by a resurgence of talk about improving education, I see at least three basic problems that are likely to occur in trying to translate the talk into action:

1. A lot of energy will be wasted, by all parts of the educational network, in blaming other parts.

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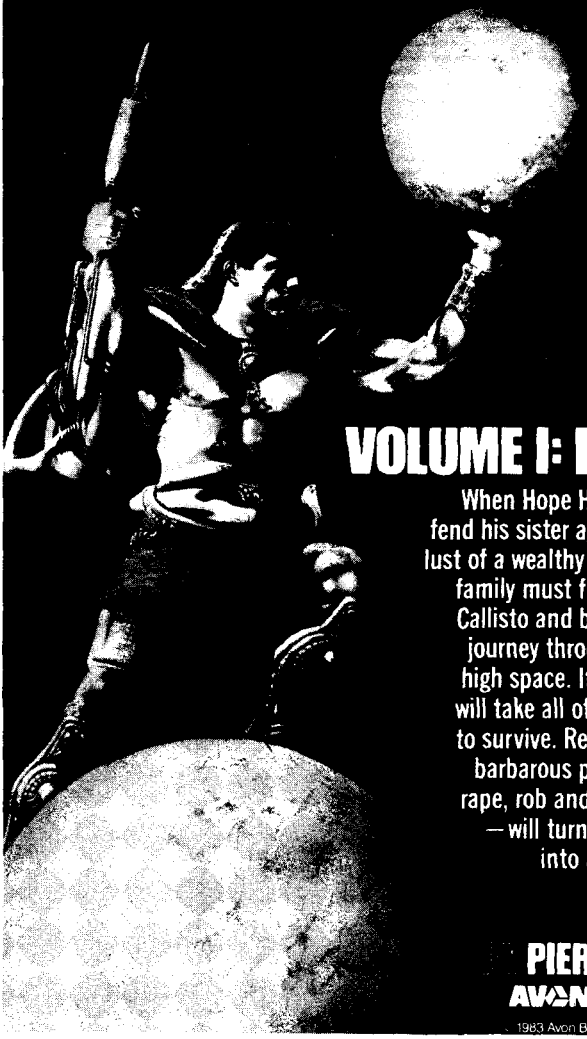
HE HAS ONE BURNING DESIRE— TO AVENGE THE ATROCIOUS SLAUGHTER HE CAN NEVER FORGET.



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2. A fad for educational reform will lead to many measures which soothe consciences without really accomplishing much—such as spending more money, requiring longer class days, and assigning more homework, without due regard for the *quality* of these activities.
3. Educational practices adopted in recent years will be scrapped in wholesale lots in favor of "a return to good old ways," without due consideration of whether the old ways are indeed all that good or whether there were valid reasons for moving away from them in the first place.

All of these pitfalls can be avoided—*if* reformers are watching out for them. But they will have to bear in mind *both* that education is a very complex chain (or web) of interactions *and* that a determined and able person in any part of it can do a lot to get the best out of it despite weaknesses in other parts.

Parents start the educational process, whether consciously or not, long before their children enter "school." They do this by providing (or failing to provide) an environment in which learning is respected and encouraged. This does not necessarily mean any formal "teaching"; in my case, it consisted principally of having parents who from a very early age left me largely alone with free access to pencils, paper, and books; openly approved my efforts to use these things; and took time to answer whatever questions I could ask. A long time ago (about Sputnik time) I heard a statement on a television documentary that most children have their curiosity and imagination squeezed out before they're sixteen; I have since become convinced that much of the damage is often done

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before *six*—by parents who disparage study and can't be bothered with questions.

School boards or their equivalents, using funds allotted by parents and other voters, provide buildings and equipment, hire and fire faculties, and (to varying degrees) oversee curricula. Laxness or misguided actions in any of these areas can cause problems—but in the effort to correct these problems, administrators can easily fall into the trap of measuring progress in dollars spent when what they need to be measuring is *educational effectiveness*. That's much harder to measure, of course, but the question of how to do it is too important to ignore.

Faculties work with what they get: operating budgets, salaries, and students. Commonly there are deficiencies in one or more of these areas; poor teachers can blame their problems on everything from stingy boards to a generation of badly raised students. There may even be considerable truth in these claims—but really *good* teachers will devote at least as much energy to finding ways over the barriers as to building excuses around them.

Students can blame poor teaching for their difficulties in learning, too often with good reason—there *is* slipshod teaching (another large subject in itself!) which ought to be improved. But in the meantime, students who *want* to learn can do so in spite of bad teaching. It won't be as easy, but it is to their advantage, and the earlier they can understand that, the better. As one of my best teachers once said, nobody can teach you anything, anyway. The best a teacher can do is help you learn—but the actual act of learning you must do for yourself. It may be that the one really important external "teaching" most students need is to be shown, believably and convincingly, why becoming educated is worth considerable effort, even without the help they rightly think they deserve.

But education works best if *all* these people—parents, students, teachers, and administrators—are doing the best they can in their own roles, trying to do them so well that education occurs even if the others aren't doing all they should. Naturally each must have some expectations of the other factions, but he must also expect (even though he *shouldn't* have to) that his own job may necessarily included some coaxing, conniving, coercing, and compensating when others fail to do theirs. What we need, in other words, is a prevalent attitude based on a "double standard"—under which each participant in the process performs his job as if he is solely responsible for the success or failure of the whole venture. ■

● Be still when you have nothing to say; when genuine passion moves you, say what you've got to say, and say it hot.

D.H. Lawrence

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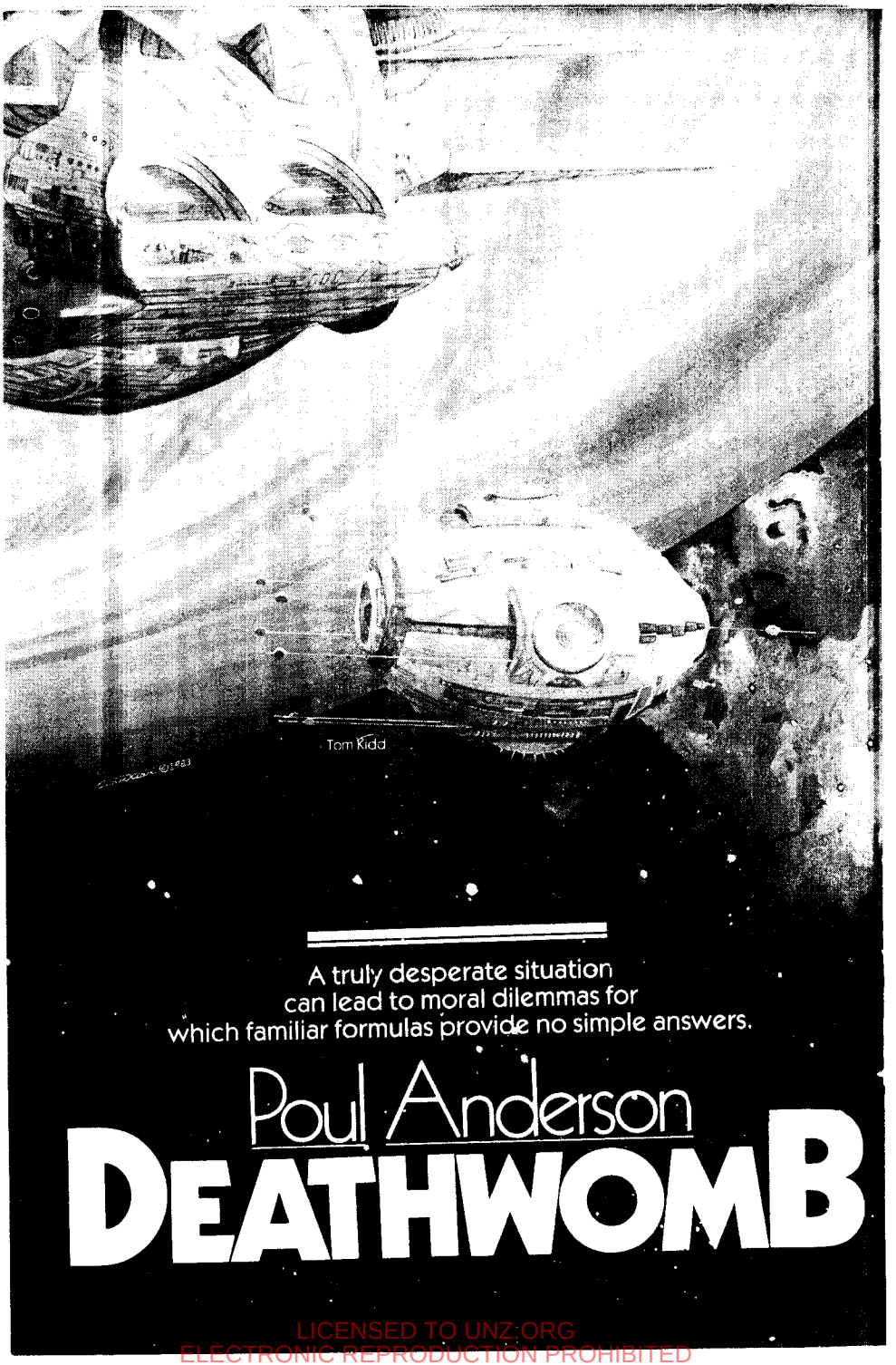

A truly desperate situation
can lead to moral dilemmas for
which familiar formulas provide no simple answers.

Poul Anderson

DEATHWOMB

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The courier slipped out of flightspace and paused for a navigational sight. It was still very far from the berserker sun, so far that that fierce blue-white A star was only the brightest of many. Others crowded heaven, unwinking brilliances every hue from radio to gamma, save where the Milky Way foamed around blackness or a nearby dark nebula loomed like a thunderhead. The torpedo shape of the courier shimmered wanly amidst them.

Having gotten its bearings, it accelerated under normal drive. At first it was receding, but soon it had quenched its intrinsic velocity and thereafter built up sunward speed. The rate of that, uncompensated, would have spread flesh and bone in a film through any interior. But there were neither cabins nor passengers: the courier was essentially solid-state.

It began to broadcast, at high power and on several wavebands. The message was in standard English. "*Parley. Parley. Parley.*" As haste mounted, frequencies changed to allow for Doppler shift, to make certain the message would be received. After all, the courier was unmistakable human work. Unless they had some reason not to, the berserkers would attack it. Such a move would be motivated less by fear of what a warhead might do to one of their proud battlecraft than what might happen to the asteroid mines and spaceborne factories they had established.

Motivation: fear: pride—nonsense words, when used about a set of computer-effector systems, unalive, belike unaware, programmed to burn life out of the universe.

But then, the courier was an autom-

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aton too, and nowhere nearly as complex or capable as the least berserker.

"*Parley. Parley. Parley.*"

In due course—time made no difference to a thing that had no consciousness, but the sun blazed now with a tiny disc—a warship came forth to meet it. That was a minor vessel, readily expendable, though formidable enough, a hundred-meter spheroid abristle with guns, missile launchers, energy projectors. Its mass, low compared to a planetkiller's, made it quite maneuverable. Nonetheless flight was long and calculation intricate before it matched the velocity which the courier by then had.

"*Cease acceleration,*" the berserker commanded.

The courier obeyed. The berserker did likewise. Globe and minute sliver, they flew inert on parallel courses, a thousand kilometers apart.

"*Explain your presence,*" was the next order. (Command! Obedience! More nonsense, when two robots were directly communicating.)

"*Word from certain humans,*" the courier replied. "*They know you have moved into this region of space.*"

Being a machine exchanging data with another machine, it did not add the obvious. No matter how vast astronomical distances are, an operation of that size could not stay hidden long, if it took place anywhere in that small portion of the galaxy where humans had settlements with high technology. Devices even simpler than the courier, patrolling over light-years, were sure to pick up the indications on their instruments, and report back to their masters. Of course, those were not necessarily all the humans in the stellar neighborhood. Nor did it follow that they could do much to prevent onslaughts out of the new base. Their own strength was thinly scattered, this far from the centers of their older civilizations. At best, they could marshal resources for the defense of some worlds—probably not all.

The berserker did not waste watts inquiring what the message was. It merely let the courier go on.

"*Their analysis is that you will soon strike, while you continue to use the mineral and energy resources of the planetary system for repair and reproduction. If an overwhelming human force moves against you, you will withdraw; but that cannot happen in the immediate future, if ever. My dispatchers offer you information of value to your enterprise.*"

Logic circuits developed a question. "*Are your dispatchers goodlife?*"

"*I am not programmed with the answer, but there is no indication in my memory banks that they wish active cooperation with you. It may be a matter of self-interest, the hope of making a bargain advantageous to them. I can only tell you that, if the terms are right, they will steer you to a target you would not otherwise know about: an entire world for you to sterilize.*"

Radio silence fell, except for the faint seething of the stars.

The berserker, though, required just a split second to make assessment. "*Others shall be contacted before you leave. We will arrange a rendezvous for proper discussion, and you will bring a record of the proceedings back to your*

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humans. Within what parameters do they operate?''

The Ilyan day stood at midmorning when Sally Jennison came home. The thaw and the usual storms that followed sunrise were past and heaven was clear, purplish-blue, save for a few clouds which glowed ruddy here and there. Eastward the great ember was climbing past Olga; shadows made sharp the larger craters upon the moon. Below, the Sawtooth Mountains rose dusky over the horizon, Snowcrown peak agleam as if on fire.

Elsewhere land rolled gently, so that the Highroad River flowed slow out of the west on its way to Lake Sapphire. The boat had left wilderness behind and was in the settled part of Geyserdale. Grainfields rippled tawny on either side; they had thus ripened, been harvested, been resown, ripened again with the haste that the brief Ilyan year brought about, several times since the expedition departed. A village of beehive-rounded houses was visible in the northern distance, and occasional natives working near the stream hailed Sally and her companion. They were not many, for she had yet to hear of any society on this planet where persons liked to crowd together. Timberlots were plentiful, high boles and russet foliage. Steam blew from encrusted areas where hot springs bubbled, and once she saw an upward spout of water.

Insectoids flitted on glittery wings. A windrider hovered aloft. River and breeze murmured to each other. Air had warmed as day advanced, and grown full of pungencies. An unseen coneycat was singing.

The peacefulness felt remote from Sally, unreal.

Abruptly it broke. She had hooked her transceiver into the electrical system of the boat's motor and inserted a tape for direct readout and continuous, repeated broadcast: ''*Hello, University Station. Hello, anybody, anywhere. This is the Jennison party returning after we stopped hearing from you. I've called and called, and gotten no response. What's wrong? Reply, please reply.*''

Sound from the set was a man's voice, harsh with tension, the English bearing a burred accent unfamiliar to her: ''Wha's this? Who are ye? Where?''

She gasped, then got her balance back. Years in strangeness, sometimes in danger, had taught her how to meet surprise. Underneath, she felt a tide of relief—she was not the only human left alive on Ilya!—but it carried an ice flow of anxiety. What had become of them, her friends, every one of the hundred-odd researchers and support personnel at the base and exploring around the planet?

She must wet her lips before she could answer. ''Sally Jennison. I've been doing xenological work in the field, Farside, for the past twenty days or so.'' The man was perhaps not used to the slow rotation of Ilya. ''Uh, that would be about six months, Terrestrial. When communication cut off—yes, of course I could send and receive that far away, we do have comsats in orbit, you know—I grew alarmed and started back.''

''Where are ye?'' he demanded. ''Who's wi' ye?''

''I'm on the Highroad River, passing by Dancers' Town. About a hundred

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fifty klicks west of the station, it is. I've only one partner left, a native who lives near us. The rest of my expedition, all natives too, have disembarked along the way and gone to their own homes."

Anger flared. "Enough!" she exclaimed. "Jesus Christ! Suppose you tell me who *you* are and what's going on?"

"No time," he said. "Your people are safe. We'll ha' someone out in an aircar to pick ye up as fast as possible. Meanwhile, cease transmission. Immediately."

"What? Now you listen just a minute—"

"Dr. Jennison, the berserkers are coming. They may arrive at any minute, and they must no' detect any electronics, any trace o' man. Under martial law, I lay radio silence on ye. Turn your set off!"

The voice halted. Numbly, Sally reached for the switch of her unit. She slumped on her bench, stared, scarcely noticed that she was still at the rudder.

Rainbow-in-the-Mist stroked a four-fingered hand shyly over hers. In a short-sleeved shirt, she felt his plumage (not hair, not feathers; an intricate, beautiful, sensitive covering for his skin) tickle her arm. "Have you news at last, Lady-Who-Seeks?" he trilled, whistled, hummed.

"Not quite," she said in English. They could understand if not pronounce each other's languages, though the new intonation had baffled him. "Whoever it was did claim my people are safe."

"That good makes any ill very slight." He meant it.

But your *people are in mortal danger!* she almost cried out. *Your whole world is.*

She gazed at her friend of years as if she had never before seen any of his kind—body somewhat like hers, but standing only to her chin and more gracile; round head, faun ears, short muzzle, quivering cat-whiskers, enormous golden eyes; delicate gray sheen of plumage; the belt, pouch, and bandolier that were his entire garb, the steel knife he carried with such pride not because it was a rare thing in his chalcolithic society but because it was a present from her. . . . She had seen images of planets the berserkers had slain, radioactive rock, ashen winds, corrupted seas.

But this is insane! she thought suddenly. *They've never heard of Ilya. They couldn't have, except by the wildest chance, and if that happened, how could that man have known?*

And he wanted me to stop sending in case a berserker detected it, but what about the flyer he's dispatching for me? . . . Well, that may be a risk he feels he has to take, to get me under cover in a hurry. A small vehicle is less likely to be spotted optically within a short time-slot than a radio 'cast is to be picked up electronically.

But what about our relay satellites? What about University Station itself, buildings, landing strip, playing field, everything?

Why didn't anybody mention me to those . . . human . . . invaders?

Rainbow-in-the-Mist patted the yellow hair falling in a pony tail past her neck. "You have great grief, I sense," he breathed. "Can your wander-brother give comfort in any way?"

"Oh, Rainie!" She hugged him to

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her and fought not to weep. He was warm and smelled like spices in the kitchen when she was a child on Earth.

A buzz from above drew her heed. She saw a teardrop shape slant down from the eastern sky. It crossed the sun's disc, but a brief glance straight at a red dwarf star didn't dazzle her vision. She identified it as an aircar. The model was foreign to her. Well, her race had colonized a lot of planets over the centuries, and no planet is a uniform ball; it is a world. Ilya alone held mystery and marvel enough to fill the lifetimes of many discoverers—

The car landed on the left bank, where springturf made an amethystine mat. A man sprang out and beckoned to her. He was tall, rawboned, clad in a green uniform which sunlight here gave an ugly hue. His tunic was open at the throat and carelessly baggy at the beltline, around a sidearm, but his stance bespoke discipline.

She brought the boat to shore, stopped the motor, got out. Seen close, the man was craggy-featured and clean-shaven. Furrows in the weathered face and white streaks through the short dark hair suggested he was in his forties, Earth calendar. Comet insignia glittered on his shoulders and a sleeve patch displayed calipers athwart a circuit diagram.

In his turn, he gave her a raking glance. She was almost thirty, not much less in height than he, well built, lithe from a career spent in the field. He gave her a soft salute. "Ian Dunbar, captain, engineer corps, Space Navy of Adam," he introduced himself. His accent was similar to that of the fellow who had happened to hear her call, but a trained ear could tell that it was not identical. Likely he hailed from a different continent . . . yes, she knew about Adam, since the planet was in this general region, but her information was scanty. . . . "Please get inside. We'll gi' your fere a ride too if he wishes."

"No, he'll bring the boat in," she objected.

"Dr. Jennison," Dunbar said, "yon's too large a craft to singlehand wi'out a motor, which we shall ha' to remove and bring back wi' us." He turned his head toward the car. "Cameron, Gordon, out and to work!" he shouted.

"Aye, sir." Two younger men wearing the same uniform, without officer's emblems, scrambled forth, bearing tools.

The hand of Rainbow-in-the-Mist stole into Sally's. "What is happening?" he asked fearfully. And yet he had met the charge of a spearhorn, armed with nothing but his knife, and distracted the giant till she could retrieve her rifle. He had been her second in command when she fared away to study natives as unknown to him as to her —most recently, when the quest took them to lands which never saw the moon that hung forever in his home sky and which he called Mother Spirit. . . .

"I don't know," she must admit. "There was talk of an, an enemy."

"What does that mean?" he wondered. Nowhere on Ilya had she heard of war or even murder.

"Dangerous beings, maddened beasts." The thought of nuclear missiles and energy beams striking this place was like a drink of acid.

"Hurry along!" Dunbar rapped.

Sally and her comrade squeezed into the rear seat beside him. The two noncoms followed, after stowing the motor

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and other stuff from the boat. They took the front, one of them the controls. The aircar lifted. In spite of everything, Rainbow-in-the-Mist caroled delight. He seldom got to fly.

Sally felt how Dunbar perforce pressed against her. She didn't want to be, but was, aware of his maleness. It had been long since she said goodbye to Pete Brozik and Fujiwara Ito. The first a planetologist, the second a molecular biologist, her lovers couldn't very well go xenologizing with her.

Apprehension stabbed. How were they? Where?

It turned to resentment. "Well, Captain Dunbar," she clipped, "now will you tell me what the hell is going on?"

The ghost of a smile flitted over his starkness. "That is wha' I believe your folk would call a tall order, Dr. Jennison."

"Huh?" She was surprised.

"Ye're originally fro' North America on Earth, true?"

"Y-yes. But how do you know, when an hour ago you didn't know I existed?"

He shrugged. "Speech, gait, style. I've seen shows, read books, met travelers. Just because we Adamites are out near the edge o' human expansion, take us no' for rustics." The ghost sank back into its grave. The gaze he turned on her was bleak. "Maybe we were once, our forefathers, and glad to be, but the berserkers ended that. Wha' I would like to find out this day is why nobody told us about ye, Dr. Jennison. We'd ha' sent a car to fetch ye. Now I fear ye're trapped, in the same danger as us."

Sally checked her temper, pinched her lips, and made her blue stare challenge his gray before she said: "I can scarcely give you any ideas before I have some facts, can I? What's been happening? Who are you people, anyway? And what's become of mine?"

Dunbar sighed. "We've evacuated them. Aye, 'twas hasty and high-handed, no doubt, but we were under the lash oursel's. The first thing we removed was the comsats; that's why ye were no longer receiving or being heard, though 'twas but a short time before we imposed silence on every transmission. Meanwhile—"

The car started downward. Sally looked past Dunbar, out the window. She choked back a scream.

Lake Sapphire shone enormous below, surrounded by the rural tranquility she had known throughout her stay on Ilya. Eastern mountains, red sun-wheel, scarred and brilliant moon were untouched. But where the Highroad River emptied into the lake, where University Station had clustered, was a blackened waste, as if a noonday turf fire had spread over that ground and consumed the very buildings, or the berserkers had already commenced their work.

Space was steely with stars. None shone close in the loneliness here. What established this rendezvous point was triangulation on distant galaxies.

Emerging from flightspace, the berserker homed on a broadcast that Mary Montgomery's ship had been emitting while she waited. Instruments showed the vessel draw nigh and match intrinsics—lay to—a thousand kilometers off. Magnifying optics showed it as no bigger than hers, though a hedgehog of armament, dim shinings and deep shadows near the Milky Way.

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Alone in the main control room, for her crew was minimal, she settled herself into a command chair and pressed the lightplate which would signal her readiness to talk. Around her, bulkheads stood dull-hued, needles quivered across dials, displays went serpentine, electronics beeped and muttered. The air from the ventilators smelled faintly of oil, something a bit wrong in the recyclers, no matter what. Her old bones ached, but no matter that, either.

The berserker's voice reached her. It was derived from the voices of human captives taken long ago, shrill, irregular, a sonic monster pieced together out of parts of the dead, terrifying to many. Montgomery sniffed at it, took a drag on her cheroot, and blew a smoke ring toward the speaker. *Childish bravado*, she thought. But why not? Who was to witness?

"Parley under truce, is this still agreed?" the berserker began.

Montgomery nodded before recollecting how pointless the gesture was. "Aye," she said. "We've somewhat to sell ye, we do."

"Who are you, where is that planet your courier bespoke, what is your asking price?"

Montgomery chuckled, though scant mirth was in her. "Easy, my ghoulie. Ye, your kind, ye've established yoursel's in these parts again, so as to kill more, no? Well, last time my home suffered grimly. We've better defenses this while, we can fight ye off, yet 'twould be at high cost. Suppose, instead, we direct ye to another inhabited world—not a human colony, for we're no traitors, understand—a world useless to us, but wi' life upon it for ye to scrub out, aye, e'en an intelligent species. They're primitives, helpless before ye. A single capital ship o' yours could make slag o' the planet in a day or two, at no risk whatsoe'er. In exchange for such an easy triumph, would ye leave us in peace?"

"Who are you?"

"Our world we call Adam."

The berserker searched its memory banks. "Yes," it said. "We struck it three hundred and fifty-seven Terrestrial years ago. Considerable damage was done, but before the mission could be completed, a task force of the Grand Fleet arrived and compelled us to retreat. We were only conducting a raid. We had no reinforcements to call upon."

"Aye. Since then, Adam has gained strength."

"And this time we have a base, a planetary system, raw materials to build an indefinite number of new units. Why should we not finish Adam off?"

Montgomery sighed. "Were ye human—were ye e'en alive, conscious, insultable, ye metal abomination—I'd ask ye to stop playing games wi' me. Well, but I suppose your computer does no' ha' the data. 'Tis been long since ye last came by. So hearken.

"In spite o' the wounds ye inflicted, Adam has a larger population now than then, much more industry, a small but formidable space navy, a civil defense that reaches through the whole system 'tis in. Ye could no' take us out before the marshalled human forces arrive to drive ye back fro' this sector. Howe'er, we'd liefest be spared the loss o' blood and treasure that standing ye off would entail. Therefore we offer our bargain—a world for a world."

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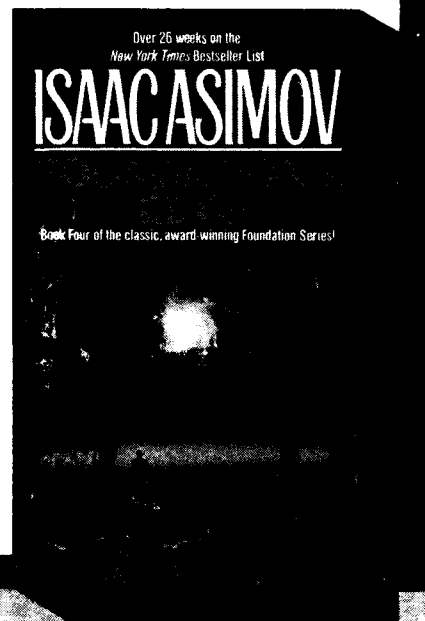
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Lack of life did not mean lack of shrewdness. "If the target you would betray is so soft," the berserker inquired, "why should we not afterward turn on you?"

Montgomery drew a little comfort from the bite of smoke in her mouth, more from the family picture above the control console. Her husband was in it, and he had died, oh, Colin, Colin . . . but her sons and daughters stood strong beside their wives and husbands, amidst her grandchildren and his. She had volunteered for this mission because a human was needed—no computer that humans could build was flexible enough—and if negotiations broke down and the berserker opened fire, why, she was old and full of days.

"I told ye ye'd find us a hard nut to crack," she answered, "and this ye can verify by a scouting flit. Only pick up the stray radiations fro' orbital fortresses and ships on patrol. Afterward think wha' ground-based installations we must ha' likewise—whole rivers to cool energy projectors— Ah, but ye do no' really think, do ye?"

"Nevertheless, it might prove logical for us to attack you, especially if we have been able to accomplish part of our sterilizing objective without loss to our forces."

Montgomery made a death's-head grin at the image of the ship among the stars. "But see ye," she declared, "before we turn over yon hapless planet to ye, we'll send forth courier robots far and wide. They'll bear witness—our recordings, your electronic signature —witness to the treaty, that we gi' ye the information in return for immunity.

"Ye've struck bargains wi' humans erenow. Break one as important as this, and how much goodlife can ye hope to recruit in future?"

The machine did not ask any further questions such as she would have asked in its place. For instance, how would humans throughout space react to fellow humans, Adamites, who had sold out a living world in order that they themselves be spared a war? Subtleties like that were beyond a machine. Indeed, Montgomery confessed wearily to herself, they were beyond her, and every expert who had debated the issue. There might not be great revulsion, and what there was might not last long. Nonhuman intelligences were rare, scientifically valuable, but, well, nonhuman. Your first obligation was to your kindred, wasn't it?

And it was nonhumans that had built the first berserkers, untold ages ago, and programmed them to destroy everything alive, as a weapon in a damned forgotten war of their own. Wasn't it?

Silence hummed, pressed inward, filled her skull. Then:

"This unit is equipped to make agreement on behalf of our entire force," the berserker said. "Very well, in principle. To begin, provide some description of the planet you would give us."

The sun plodded toward noon while Olga waned. The moon's night part was not invisible where it hung halfway up heaven, east-southeast beyond the Sawtooths. A tenuous atmosphere caught sunlight on clouds, reflected Ilyalight, made a shimmering alongside the pocked daylit horn; the north polar cap reached thence like a plume.

Sally was used to the sight, but all

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at once she wondered how alien it might be to Dunbar: a somber red sun showing six and a half times as wide as Sol did on Earth, taking more than a week to go from midday to midday but less than a month from midsummer to midsummer; a moon almost four times the breadth of Luna in Terrestrial skies, more than twenty times the brightness, that never rose or set save as you traveled across Ilya. What was the sky of Adam like?

That hardly seemed relevant to the disaster around. But she had been stunned by it, and the hours after she landed had hailed more blows upon her. Descent to the caverns the Adamites had dug while, above, they tore University Station apart and sank the fragments beneath the lake—uniformed strangers swarming antlike through those drab corridors, loud orders, footfalls, throb of unseen machinery—a cubicle found for her to sleep in, a place assigned at the officers' mess, but she had no appetite—warm, stinking air, for there had been no time to install anything but minimal life support, when the complex of workshops, command posts, barracks must be gnawed out of rock and reinforced till it could withstand a direct hit of a megaton—a fantastic job in so short a span, even granting powerful, sophisticated machines to do most of the labor— *Why, why, why?*

Andrew Scrymgeour, admiral in overall charge of operations, received her, though only for a brief interview. He had too many demands on him as was. Weariness had plowed his face; the finger that kept stroking the gray mustache was executing a nervous tic; he spoke in a monotone.

"Aye, we're sorry we missed ye. I set an inquiry afoot when I heard. As nigh as my aide can find out, 'twas because o' confusion. Such haste on our part, ye see, and meanwhile such anger among your folk, arguments, refusals that bade fair to become outright physical resistance, did we no' move fast and firmly. Other scientists were in the field besides ye, o' course, scattered o'er half this globe. We sought them out and brought them in, thinking they were all. We did no' stop to check your rosters, for who would wish anyone left abandoned? Somehow we simply were no' told about ye, Dr. Jennison. Doubtless everybody among your friends took for granted somebody else had gi'en that word, and was too furious to speak to us unless absolutely necessary. Moreo'er, we could no' lift the lot o' them off in a single ship, we required several, so on any one vessel 'tis being assumed ye must be aboard another."

Yes, Pete and Ito will be horror-smitten when they learn, Sally thought. *Worst will be the helplessness and the not knowing; worse for them than me, I suppose. (Oh, it isn't that we've exchanged vows or anything like that. We enjoy each other, minds more than bodies, actually. But it's made us close, affectionate. I've missed them very much, calm and grizzled Ito, Pete's vitality which a man half his age might envy—)*

"Where have you taken them?" she demanded.

Scrymgeour shrugged. "To Adam. Where else? They'll be comfortably housed until arrangements can be made for sending them on to their homes, or where'er is appropriate. Maybe e'en back here, to take up their work again."

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He sighed. "But that requires clearing the berserkers fro' this sector o' space. Meanwhile, travel may prove so dangerous that our authorities will deem it best to keep your folk detained, for their own safety."

"For their silence, you mean!" she flared. "You had no right, no right whatsoever, to come in like this and wreck all we've built, halt all we've been doing. If Earth found out, it might be less ready to send naval units to help defend Adam."

Scrymgeour's bushy brows drew together. "I've no time to argue wi' ye, Dr. Jennison," he snapped. "'Tis unfortunate for us as well as ye that ye were overlooked in the evacuation." He curbed his temper. "We'll do wha' we can. I'll see to it that an officer is assigned to ye as . . . liaison, explainer." Dour humor: "Also chaperon, for ye realize we've but a handful o' women on Olga now, and they too busied for aught o' an amorous nature. Not that our men would misbehave, I'm sure; but 'twill be as well to make plain for them to see that they're no' to let themsel's be distracted fro' their duty, e'en in their scant free times."

Sally tossed her head. "Don't worry, Admiral. I have no desire to fraternize. Am I permitted to take myself out of their presence?"

"Go topside, ye mean?" He pondered. "Aye, no harm in that, gi'en proper precautions. We do oursel's. Howe'er, ye shall always ha' an escort."

"Why? Don't you think I might conceivably know my way around just a tiny bit better than any of your gang?"

He nodded. "Aye, aye. But 'tis no' the point. Ye mustn't stray far. Ye must e'er be ready to hurry back on the first alarm, or take cover if the notice is too short. I want someone wi' ye to make sure o' that. 'Tis for your sake also. The berserker is coming."

"If I couldn't dive underground before the strike," she sneered, "what's the point of my ducking under a bush? The whole valley will go up in radioactive smoke."

"Ah, but there's a chance, extremely small but still a chance, that the berserker would spy ye fro' above." Scrymgeour bit off his words. "Pardon me. I've my job on hand. Return to your quarters and wait to hear fro' the officer detailed to ye."

That turned out to be Ian Dunbar. So it was that she found herself wondering what he thought of her sky.

"Ye see," he disclosed awkwardly —shyly?—"the part o' the task I'm in charge o', 'tis been completed, save for minor and routine tinkerings. I'll no' be much needed any more until action is nigh. Meanwhile, well, we owe ye somewhat. Apology, explanation, assistance in rebuilding when that becomes possible. I'll . . . take it on mysel' . . . to speak for that side o' us . . . if ye're willing."

She gave him a suspicious glance, but he wasn't being flirtatious. Quite likely he didn't know how to be. He stared straight ahead of him as they walked, gulped forth his words, knotted knobbly fists.

The temptation to be cruel to such vulnerability was irresistible, in this wasteland he had helped make. "You've given yourself plenty to do, then. Four

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universities in the Solar System pooled their resources, plus a large grant from the Karlsen Memorial Foundation, to establish a permanent research group here. And how do you propose to restore the working time we'll've lost, or repair the relationships with natives that we've painstakingly been developing?" She swept a hand to and fro. "You've already created your own memorial."

Cinders crunched underfoot. Grit was in the breeze. The settlement had been razed, bulldozed over, drenched in flammables, and set alight. Whatever remained unburnt had been cast in the lake. She must admit the resemblance to a natural area damaged by a natural fire was excellent.

Dunbar winced. "Please, Dr. Jennison. Please do no' think o' us as barbarians. We came to wage war on the olden enemies o' all humankind, all life." After a pause, softly: "We respect science on Adam. I'd dreams mysel' as a lad, o' becoming a planetologist."

Despite her will, Sally's heart gave a small jump. That was what her father was. *Oh, Dad, Mother, how are you, at home on Earth? I should never have stayed away so long.*

—No. I will not *let myself like this man.*

"Don't change the subject," she said as sharply as she could manage. "Why have you come to Ilya? What crazy scheme have you hatched, anyway?"

"To meet the berserker when it arrives. Ye'd absolutely no defenses in this entire planetary system."

"None were needed."

They left the blackened section behind and trod on springturf, a living recoil beneath the feet, purple studded with tiny white flowers. Following the lakeshore, several meters inland, they started up a slope which ended in a bluff above the water. Now the wind was clean; its mildness smelled of soil and growth.

"The berserkers would never have dreamed life was here," Sally said. "It's so great a miracle."

"Berserkers do no' dream," Dunbar retorted sternly. "They compute, on the basis o' data. Ilya's been described in newscasts, aye, at least one full-length documentary show. Ye've been publishing your findings."

"The news sensation, what there was of it, died out ten or fifteen years ago, when no berserker was anywhere near this part of space—or near our inner civilizations either, of course. Besides, how would they pick up programs carried on cable or tight beam—between stars, in canisters? As for publication since the original discovery, I don't believe berserkers subscribe to our specialized scientific journals!"

"Well, they do know."

"How? And how can you be sure of it?"

"Our intelligence—I'm no' at liberty to discuss our methods. Nor is that my corps, ye remember."

"Why haven't they come already, then? We'd've been a sitting duck."

He blinked. "A wha'?"

She couldn't help smiling. His puzzlement made him too human, all of a sudden. "An Earth expression. North American, to be exact. I don't know what sort of waterfowl you have on Adam."

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His haggardness returned. "Few, sin' the berserkers visited it."

After a moment, he offered a reply of sorts to her question. "We can no' tell when the raid will happen. We can but prepare for it as fast and as best we are able."

They surmounted the bluff and stopped to rest. A while they stood side by side, gazing out over the broad waters. He breathed no harder than she did. *He keeps in shape, like Dad,* she thought. The wind ruffled her hair and cooled away the slight sweat on her face, phantom caresses.

"I take it," she said at last, slowly, "you couldn't detach any large force from the defense of Adam itself. So what have you brought? What are your plans?"

"We've a few spacecraft hidden on both the planet and yon moon. Everything is electronically shielded. Heat radiation fro' the base will no' matter in this area, which had it already." Dunbar gestured ahead. "My task was mainly beneath the loch. We've installed certain ultra-high-powered weapons . . . camouflage and cooling alike—" He broke off. "Best I say no more about it."

She scowled at the upborne silt and shapeless trash which marred the purity of the wavelets. That defilement would surely mean nothing to a berserker—what did a robot know of the nature it was only intended to murder?—but to her, and Rainbow-in-the-Mist, and everybody else who had dwelt near these shores and loved them—

Her wits were beginning to straighten out, though her head still felt full of sand. "You're laying a trap," she said.

He nodded. "Aye, that's obvious." His laugh clanked. "The trick is to keep it fro' being obvious to the enemy, until too late."

"But . . . hold on . . . won't the disappearance of our works be a give-away?"

"Make the foe suspicious, ye mean? Nay, that's the whole point. They know no' that Earth is aware o' this planet. 'Twas found just by chance, was it no', in the course o' an astrophysical survey? The general staff on Adam has decided that that chance could become an opportunity for us, to gi' them a blow in their metal bellies."

Dunbar glanced at her, at his watch, and back again. His tone gentled. "Lass—Dr. Jennison—'tis late by human clocks. Ye've had a rude shock, and I'm told ye've no' eaten, and ye do look fair done in. Let me take ye to some food and a good long sleep."

She realized it herself, weariness and weakness rising through her, breaking apart whatever alertness she had left. "I suppose you're right," she mumbled.

He took her elbow as they started down. "We need no' talk any further if ye'd liefer no'," he said, "but if ye would like a bit o' conversation, shall we make it about somewhat else than this wretched war?"

Mary Montgomery drew breath. "We discovered it by sheer accident," she told the berserker. "An astrophysical survey. Diffusion out o' yon nebula has minor but interesting effects on ambient stars—and on some more distant, as stellar light pressure and kinks in the galactic magnetic field carry matter off

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until it reaches a sun. An expedition went forth to study the phenomena closer.

"Among the samples it picked, more or less at random out o' far too many possibilities for a visit to each—among them was a red dwarf star, middle type M. They found it has a life-bearing planet."

An organic being should have registered surprise. The machine afloat in space said merely: "That is not believed possible. Given a low-temperature heat source, the range of orbits wherein water can be liquid is too narrow."

"'Tis no' impossible, just exceedingly improbable, that a planet orbit a cool sun in the exact ellipse necessary."

"And it must have the proper mass, be neither a giant dominated by hydrogen nor an airless rock."

"Aye, that makes the situation unlikelier yet. Still, this world is o' Earth size and composition."

"Granted that, it must be so close to its primary that rotation becomes gravitationally locked, not even to two-thirds the period of revolution, but to an identity. One hemisphere always faces the sun, the other always faces away. Gas carried to the dark side will freeze out. Insufficient atmosphere and hydrosphere will remain fluid for chemical evolution to proceed to the biological stage."

Montgomery nodded her white head. Inwardly she wondered if the berserker carried that knowledge in its data banks or had computed it on the spot. Quite plausibly the latter. It had an enormous capability, the pseudo-brain within yonder hull. After all, it was empowered —no, wrong word—it was able to bargain on behalf of its entire fleet.

Hatred surged. She gripped her chair arms with gnarled fingers as if she were strangling the thing she confronted. *Nay*, she thought in the seething, *it does no' breathe. Launch a missile, then! . . . But none we ha' aboard could get past the defenses we know such a berserker has, and it would respond wi' much better armament than we carry. It could simply fire an energy beam, to slice our ship in twain like a guillotine blade going through a neck.*

Nay, no' that either, she thought, aware that the issue was altogether abstract. *'Tis o' destroyer class, no' big enough to hold the generator that could produce a beam strong enough. Dispersion across the distance between us— A dreadnaught could do so, o' course, though e'en its reach would be limited and the cut would be messy. To slash a real scalpel o'er this range, ye need power, coolant, and sheer physical size for the focusing—aye, ground-based projectors, like those we've built across Adam.*

If a fight breaks out here, the berserker will swamp our own screens and antimissiles. As for its response, it need not e'en get a hit. A few kilotons o' explosion nearby will serve full well to kill us by radiation.

But my mind is wandering. We're no' supposed to provoke a battle. I ha' indeed grown old.

She chose to prolong matters a little, not to tease the enemy, which had no patience to lose (or else had infinite patience), but to assert her life against its unlife. "A philosopher o' ours has observed that the improbable must hap-

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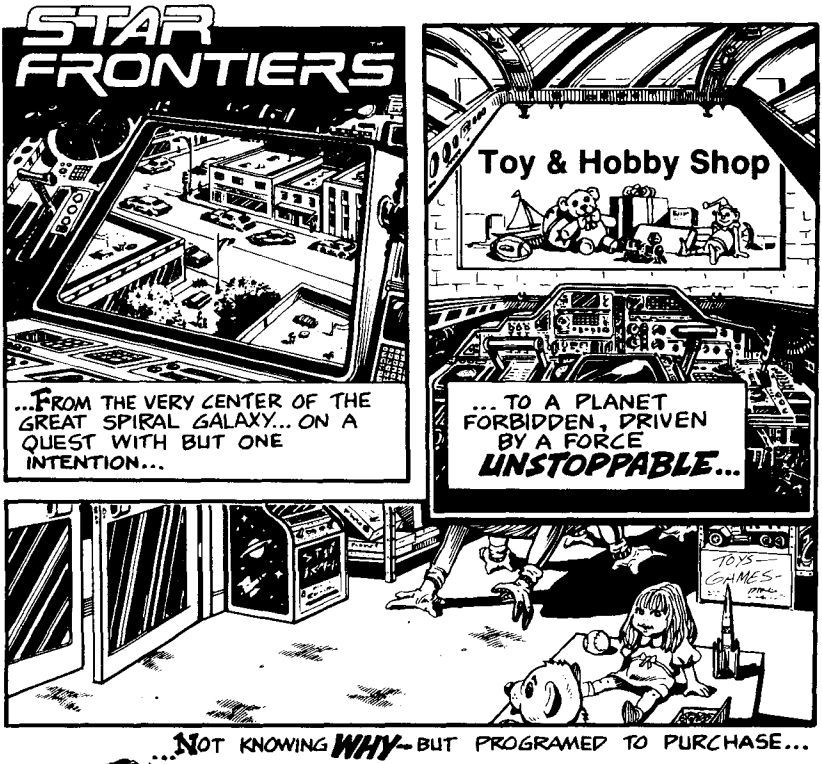
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pen," she said. "If it ne'er did, 'twould be the impossible."

The hesitation of the machine was barely sufficient for her to notice. "We are not present to dispute definitions. How does this planet you speak of come to be inhabited? Where is it? Be quick. We have too many missions to undertake for the wasting of time."

Montgomery had long since won to resolution; but the words would not die, they stirred anew. *—Then one of the twelve, called Judas Iscariot, went unto the chief priests, And said unto them, What will ye give me, and I will deliver him unto you? And they covenanted with him for thirty pieces of silver.*

She heard her voice, fast and flat: "Besides being in the right orbit, this Earth-sized planet has a Mars-sized companion. Therefore they are locked to each other, not to their sun. The period o' their spin is nine and a quarter Terrestrial days, which serves to maintain atmospheric circulation. True, nights get cold, but no' too cold, when winds blow aye across the terminator; and during the long day, the oceans store mickle heat. The interplay wi' a year that is about twenty-two Terrestrial days long is interesting—but no' to ye, I'm sure. Ye are just interested in the fact that this planet has brought forth life for ye to destroy.

"Ye ha' no' the ships to spare for a search, if ye're to carry out any other operations before an armada from our inner civilizations comes out against ye. Red dwarf stars are by far the commonest kind, ye ken.

"Make the deal. Agree that, if this world is as I've described, ye'll stay your hand at Adam, whate'er ye may do elsewhere. Let the couriers disperse wi' the attestation o' this compact between us. After that I'll gi' ye the coordinates o' the star. Send a scout to verify—a small, expendable craft. Ye'll find I spoke truth.

"Thereafter, a single capital ship o' yours can write an end to yon life."

Sally Jennison woke after twelve hours, rested, hungry, and more clear-headed than felt good. The room lent her had barely space for a bunk and her piled-up baggage from the boat. Swearing, she wrestled forth a sweatsuit, got it on, and made her way to the gymnasium of which she had been told. Men crowded the narrow corridors but, while she felt the gaze of many, none seemed to jostle her purposely, nor did any offer greetings. *A sour, puritanical pack, the Adamites,* she thought. *Or am I letting my bitterness make my judgments for me?*

A workout in the women's section, followed by a shower and change into fresh garments, took some of the edge off her mood. By then it was near noon on the clock; the rotation of the newcomers' planet was not much different from Earth's. She proceeded to the officers' mess, benched herself at the long table, and ate ravenously. Not that the food was worthy of it; her field rations had been better.

A sandy-haired young woman on her right attempted friendliness. "Ye're the stranded scientist, no? My sympathies. I'm Kate Fraser, medical corps." Reluctantly, Sally shook hands. "Ye're a . . . xenologist, am I right? Maybe, if ye've naught else to do, ye'd consider assisting in sickbay. Ye must know first

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aid, at least, and we're shorthanded. 'Twill be worse if we take casualties, come the action."

"That's no' to speak o' here, Lieutenant Fraser," warned a skinny redheaded man sitting opposite. "Besides, I do no' believe she'd fit into a naval organization." He cleared his throat. "Wi' due respect, Dr. Jennison. See ye, every hale adult on Adam is a reservist in the armed forces until old age. Thus we're better coordinated in our units than any co-opted civilian could possibly be." Pridefully: "The berserkers will no' get nigh enough again to Adam to bombard it."

Anguish and anger kindled anew in Sally. "Why did you want to interfere on Ilya, then?"

"Forward strategy," said Fraser. The redhead frowned at her and made a shushing motion.

It went unseen by a very young officer whose plumpness, unusual in this assemblage, suggested a well-to-do home. "'Tis no' sufficient to throw back the damned berserkers," he declared. "They'll still be aprowl. Travel and outlying industries will still be endangered, insurance rates stay excruciating."

Sally knew little about Adam, but a memory stirred in her. After the last assault impoverished them and their planet, many of the people went into new endeavors requiring less in the way of natural resources than the original agriculture-based society had done. A stiff work ethic and, yes, a general respect for learning gave advantages that increased through the generations. Adamite shipping and banking interests were of some importance nowadays, in their stellar sector. *Prim race of moneygrubbers*, she thought.

"The basic problem to cope wi'," the boy went on, "is that the berserkers are von Neumann machines—"

"That will do, Ensign Stewart!" interrupted the redhead. "Report to my office at fifteen hundred hours."

Scarlet and white went across the youthful cheeks. Sally guessed Stewart was in for a severe reprimand.

"Sorry, Dr. Jennison," said the redhead. His tone was not quite level. "Military security. Ah, my name is Craig, Commander Robert Craig."

"Are you afraid I'll run off and spill your secrets to the enemy?" Sally jeered.

He bit his lip. "Surely no'. But wha' ye do no' know, the berserkers can no' torture out o' ye. They could, understand. They've robots among them o' the right size, shape, mobility—like soulless caricatures o' humans."

"What about you?"

"The men, and such officers as ha' no need to know, simply follow orders. The key officers are sworn to ne'er be taken alive." Craig's glance dropped to his sidearm. Stewart seemed to regain pride.

"Can we no' talk more cheerful?" asked Fraser.

The effort failed. Conversation sputtered out.

Ian Dunbar's place had been too far up the table for him to speak with Sally. He intercepted her at the mess hall door. "Good day," he said in his odd fashion, half harsh, half diffident. "Ha' ye any plans for the next several hours?"

She glared at the angular counte-

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nance. "Have you a library? I've nothing to read. Our books, our tapes—the station's, my own, like all our personal property—are gone."

He winced. "Aye, o' course, we've ample culture along in the data banks, text, video, music. I'll show ye to the screening room if ye wish. But—um-m, I thought ye might liefer ha' some private speech, now that ye're rested. Ye could ask me whate'er ye like, and within the limits o' security I'd try to gi' honest answers."

Is this a leadup to a pass at me? she wondered. *—No, I don't suppose so. Not that it matters a lot. I'm certain I could curb him. But I suspect he curbs himself tighter than that.* "Very well. Where?"

"My room is the only place. That is, we could go topside again, but there are things ye should perhaps see and— Naturally, the door will stand open."

A smile flitted of itself across Sally's lips.

Accompanying him through the passageways, she asked why men and machines continued busy. He explained that, while the basic installations were complete, plenty more could be done in whatever time remained, especially toward hardening the site. Let her remember that the berserker would come equipped to incinerate a world.

She almost exclaimed: *You're not doing a thing to protect the Ilyans!* but blocked the impulse. Later, maybe. First she needed to learn a great deal, and that required coolness: for her refreshed brain realized how little sense everything made, of what she had heard thus far.

"You told me you're an engineer, Captain Dunbar," she angled instead. "What specialty?"

"Heavy, high-energy devices, for the most part," he replied. "In civilian life I've been on projects throughout scores o' light-years. My employers are . . . contractors supplying technical talent, ye might say. 'Tis one o' the items Adam has for export."

"How interesting. Could you tell me something I've been wondering about? I heard a reference to it when I didn't have a chance to inquire what it meant or go look it up."

His mouth creased with the pleasure of any normal man consulted by an attractive woman. "Aye, if I know mysel'."

"What's a von Neumann machine?"

He broke stride. "Eh? Where'd ye hear that?"

"I don't think it's among your secrets," she said blandly. "I could doubtless find it in the base's reference library, which you just invited me to use."

"Ah—well—" He recovered and went onward, moving and talking fast. "'Tis no' a specific machine, but a general concept, going back to the earliest days o' cybernetics. John von Neumann proposed it; he was among the pioneers. Basically, 'tis a machine which does something, but also fro' time to time makes more like itsel', including copies o' the instructions for its main task."

"I see. Like the berserkers."

"Nay!" he denied, more emphatically than needful. "A warship does no' manufacture other warships."

"True. However, the system as a whole—the entire berserker complex, which includes units for mining, refin-

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ing, production—yes, it functions as a von Neumann machine, doesn't it? With the basic program, that it copies, being the program for eradicating life. Additionally, the program modifies itself in the light of experience. It learns; or it evolves."

"Aye," he conceded, his unwillingness plain upon him, "ye can use that metaphor if ye insist."

For a moment, she wished she hadn't asked. What had it gained her? A figure of speech, scarcely anything else. And what a chilling image it was. Not alone the fact of berserker auxiliaries ripping minerals out of planets and asteroids, digesting them to fineness, turning them into new machines which carried the same code as the old, the same drive to kill. No, what made her shiver was the sudden thought of the whole hollow universe as a womb engendering the agents of death, which later came back and impregnated their mother anew.

Dunbar's words brought deliverance. His mood had lightened, unless for some reason he wanted to divert her from her idea. "Ye're a sharp one indeed," he said almost cordially. "I look forward to better acquaintance. . . . Here we are. Welcome."

Officers' quarters were individual chambers, four meters square. That sufficed for a bed, desk, shelves, dresser, closet, a couple of chairs, floor space for pacing if you grew excited or simply needed to ease tension. The desk held a computer terminal, eidophone, writing equipment, papers; the occupant must often work as well as sleep on the spot.

Sally looked around, curious. Fluorescent lighting fell chill on plastered walls and issue carpeting. Personal items were on hand, though—pictures, a few souvenir objects, a pipe rack and ashtaker, a tea set and hotplate, a small tool kit, a half-finished model of a sailing ship on ancient Earth. "Sit ye down," Dunbar urged. "Can I brew us a pot? I've oolong, jasmine, green, lapsang soochong, as ye prefer."

She accepted, chose, granted him permission to smoke. "And why not shut the door, Captain?" she proposed. "It's so noisy outside. I'm sure you're trustworthy."

"Thank ye." Did an actual blush pass beneath that leathery tan? He busied himself.

The largest picture was a landscape, valley walled by heights, lake agleam in the foreground. It did not otherwise resemble Geyserdale. Ground cover was sparse Terrestrial grass and heather. Cedars sheltered a low house from winds that had twisted them into troll shapes. A glassy-bottomed crater marred a mountainside; stone had run molten thence, before congealing into lumps and jumbles. Clouds brooded rain over the ridges. Above them, daylight picked out the pale crescents of two moons.

"Is that scene from Adam?" she inquired.

"Aye," he said. "Loch Aytoun, where I was born and raised."

"It seems to have . . . suffered."

He nodded. "A berserker warhead struck Ben Creran. The area was slow to recover, and has ne'er been fertile again as 'twas formerly." He sighed. "Though 'twas lucky compared to many. We've deserts fused solid like yon pit. Other places, air turned momentarily to plasma and soil vaporized down to bed-

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rock. And yet other places—but let's no' discuss that, pray."

She studied his lean form. "So your family isn't rich," she deduced.

"Och, nay." He barked a laugh. "The financiers and shipping barons are no' as common among us as folklore has it. My parents were landholders, on land that yielded little. They wrung a wee bit extra out o' the waters." Proudly: "But they were bound and determined their children would ha' it better."

"How did you yourself achieve that?"

"Scholarships through engineering school. Later, well-paid jobs, especially beyond our own planetary system."

You'd have to have considerable talent to do that, she thought. Her gaze wandered to another picture near the desk: a teen-age boy and girl. "Are those youngsters yours?"

"Aye." His tone roughened. "My wife and I were divorced. She took custody. 'Twas best, I being seldom home. That was the root reason why Ellen left. I see them whene'er I can."

"You couldn't have taken a sedentary position?" she asked low.

"I do no' seem to be the type. I mentioned to ye before that I wanted to be a planetologist, but saw no openings."

"Like my father," she blurted.

"He is a planetologist?"

"Yes. Professor at a college in western Oregon, if that means anything to you. He doesn't do much field work any more, but it used to take him away for long stretches. Mother endured his absences, however."

"A remarkable lady."

"She loves him." *Of course she does. It was ever worth the wait, when Dad at last returned.*

"Tea's ready," Dunbar said, as if relieved to escape personal matters. He served it, sat down facing her with shank crossed over knee, filled and ignited his pipe.

The brew was hot and comforting on her palate. "Good," she praised. "Earth-grown, I'd judge. Expensive, this far out. You must be a connoisseur."

He grinned. It made his visage briefly endearing. "*Faute de mieux*. I'd liefer ha' offered ye wine or ale, but we're perforce austere. I daresay ye noticed the Spartan sauce on our food. Well, as that fine old racist Chesterton wrote,

" 'Tea, although an Oriental,
Is a gentleman at least—' "

Startled, she splashed some of hers into the saucer. "Why, you sound like my father now!"

"I do?" He seemed honestly surprised.

"A scholar."

Again he grinned. "Och, nay. 'Tis but that on lengthy voyages and in lonely encampments, a fellow must needs read."

A chance to probe him. "Have you developed any particular interests?"

"Well, I like the nineteenth-century English-language writers, and history's a bit o' a hobby for me, especially medieval European—" He leaned forward. "But enough about me. Let's talk about ye. What do ye enjoy?"

"As a matter of fact," she admitted, "I share your literary taste. And I play tennis, sketch, make noises on a flute, am a pretty good cook, play hardnose poker and slapdash chess."

"Let's get up a game," he suggested happily. "Chess, that is. I'm more the

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cautious sort. We should be well matched."

Damn, but he does have charm when he cares to use it! she thought.

She tried putting down any further notions. The men who attracted her had always been older ones, with intelligence, who led active lives. (A touch of father fixation, presumably, but what the hell.) Dunbar, though—she would not, repeat not, call him "Ian" in her mind—he was—

Was what? The opposition? The outright enemy?

How to lure the truth out of him? *Well, Dad used to say, "When all else fails, try frankness."*

She set her teacup on the shelf beside her chair: a hint, perhaps too subtle, that she was declining continued hospitality. "That might be fun, Captain," she declared, "*after* you've set me at ease about several things."

For an instant he looked dashed, before firmness and—resignation?—deepened the lines in his countenance. "Aye," he murmured, "'twas clear ye'd raise the same questions your colleagues did. And belike more, sin' ye've a keen wit and are not being rushed as they were."

"Also, I have a special concern," Sally told him. "Not that the rest don't share it, but it was bound to affect me harder than most of them. You see, my study hasn't been the structure of the planet or the chemistry of life on it or anything like that. It's been the natives themselves. I deal directly with them, in several cases intimately. They—certain individuals—they've become my friends, as dear to me as any human."

Dunbar nodded. "And today ye see them threatened wi' extermination, like rats," he said, his tone gentler than she would have expected. "Well, that's why we came, to protect them."

Sally stiffened. "Captain, I know a fair amount about the berserkers. Anybody must, who doesn't want to live in a dream universe. If a planet is undefended, and you assure me they suppose Ilya is, then a single major vessel of theirs can reduce it in a couple of days. Therefore, they'll not likely bother to send more than that."

Dunbar puffed hard on his pipe. Blue clouds streamed past his visage and out the ventilator. She caught a tart whiff. "Aye, we've based our plans on the expectation."

"You seem to have planted your most potent weapons, ground-based, here. The berserker will scarcely happen to show first above this horizon. No, it'll assume orbit and start bombardment above some random location—sending a line of devastation across Ilya, from pole to pole, till it's swung into your range."

"That's what our spacecraft are mainly for, Dr. Jennison. They're insufficient to destroy it, but they'll draw its attention. Chasing them, it'll come into our sights."

"You're risking countless lives on that hope."

"Wha' else ha' we? I told ye, wi'out this operation, the planet is foredoomed anyhow."

"And you came in pure, disinterested altruism," she challenged, "for the sake of nonhuman primitives whom none of you had ever even met?"

He grinned afresh, but wolfishly now. "No, no. Grant us, we'd ha' been

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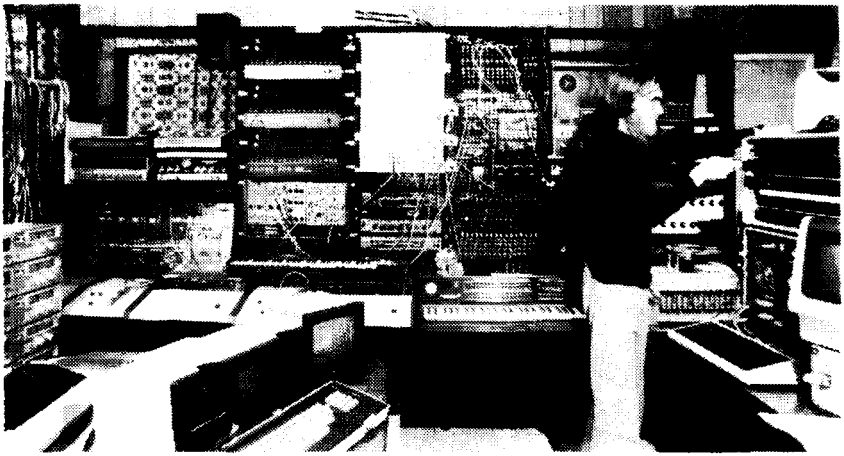

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sorry at such a cosmic tragedy. Howe'er, from our selfish viewpoint, there'll be one berserker the less, o' their most formidable kind."

She frowned, drummed fingernails on shelf, finally brought her glance clashing against his, and said: "That doesn't make sense, you know. Considering how many units their fleet must have, your effort is out of all proportion to any possible payoff."

"Nay, wait, lass, ye're no' versed in the science o' war."

"I doubt any such science exists!" she spat. "And I'd like to know how *you* know the enemy knows about Ilya. And—"

A siren wailed. A voice roared from loudspeakers, beat through the door, assailed her eardrums. "*Attention, attention! Hear this! Red alert! Berserker scout detected! Battle stations! Full concealment action!*"

"Judas in hell!" ripped from Dunbar. He sprang out of his chair, crouched over his computer terminal, punched frantically for video input. *Woop-woop-woop* screamed the siren.

Sally surged to her feet. She looked over Dunbar's shoulder. No radar, of course, she realized, nothing like that, which the intruder might notice; instruments in use were passive, optics, neutrino detectors, forcefield meters—

They did not spy the vessel from Lake Sapphire. The coincidence would have been enormous if it had passed above. However, from devices planted elsewhere the information, scrambled to simulate ordinary radio noise, went to the fortress. His screen showed a burnished spindle hurtling through the upper air. It passed beyond sight.

He sagged back. She saw sweat darken his shirt beneath the arms. She felt her own. "The scout," he whispered. "'Tis verified—"

"*Bandit has left atmosphere and is accelerating outward,*" chanted the loudspeaker. "*Reduce to yellow alert. Stand by.*"

Silence rang.

Slowly, Dunbar straightened and turned to Sally. His voice rasped. "We'll ha' action soon."

"What did it want?" she asked, as if through a rope around her neck.

"Why, to make sure Ilya remains unguarded."

"Oh . . . Captain, excuse me, this has been a shock, I must go rest a while."

Sally whirled from him and stumbled out into the hallway. "No, don't come along, I'll be all right," she croaked. She didn't look behind her to see what expression might be on his face. He didn't seem entirely real. Nothing did.

The knowledge grew and grew inside her, as if she were bearing a death in her womb. *Why should the berserkers send a scout? The original chance discovery and whatever investigation followed, those should have been plenty. In fact, why didn't they strike Ilya at once, weeks ago?*

Because they didn't know, until just lately. But the Adamites say they did. And the Adamites were expecting *that spyship.*

Then it must be the Adamites who betrayed us to the enemy. Are they goodlife? Do they have some kind of treaty with the berserkers? If not, what is their aim?

What can I do? I am alone, delivered

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into their hands. Must I sit and watch the slaughter go on?

Even as she groped her way, an answer began to come.

A few food bars were left in her baggage. She stuffed them into pockets of her coverall. Ilyan biochemistry was too unlike Terrestrial for a human to eat anything native to the planet. By the same token, she was immune to every Ilyan disease. Water would be no problem—unless it got contaminated by radioactive fallout.

Return to Dunbar's room, she thought desperately. *If he's still there. If not, find him. Persuade him . . . But how? I'm not experienced in seduction or, or anything like that. . . . Somehow, I've got to talk him into covering for me.*

He saved her the trouble. A knock on her door caused her to open it. He stood outside, concern on his countenance and in his stance and voice. "Forgi' me, I'd no' pester ye, but ye acted so distressed— Can I do aught to help?"

The knowledge of her power, slight though it was, came aglow in Sally like a draught of wine. Abruptly she was calm, the Zen relaxation upon her which Ito had tried to teach, and totally determined. Win or lose, she would play her hand.

"Don't you have duties, Captain?" she asked, since that was a predictable question.

"No' at once. The berserker scout is definitely headed out o' this system. 'Twill take fifty or sixty hours at least for it to report back and for a major ship to get here. Belike the time will be longer." He hesitated, stared at the floor, clamped his fists. "Aye, they'll soon require me for final inspections, tests, drills, briefings. But no' immediately. Meanwhile, is there any comfort I can offer ye?"

She pounced. "Let me go topside," she said mutedly.

"Wha'?" He was astonished.

I'm not used to playing the pathetic little girl, she thought. *I'll doubtless do it badly. Well, chances are he won't know the difference.* She forced out, "It may be my last walk around this countryside I love. Oh, please, Captain Dunbar—Ian—please!"

He stood silent for several heartbeats. But he was a decisive man. "Aye, why no'? I'm sorry—surely ye'd liefer be alone—my orders are that I must accompany ye."

She gave him a sunburst smile. "I understand. And I don't mind at all. Thank you, thank you."

"Let's begone, if ye wish." Willy-nilly, she found that his gladness touched her.

Save for the pulse of machines, the corridors had quieted. Men were closing down their construction jobs and preparing for combat. As she passed a chapel, Sally heard untrained singers:

"—Lord God o' warrior Joshua,
Unleash thy lightnings now!"

She wondered if the hymn spoke to Dunbar or if he had left the Kirk and become an agnostic like her.

What did that matter?

A ladder took them past a guard station where the sentries saluted him, and up onto desolation. A breeze off the lake cooled noontide heat. Clouds blew in ruddy-bright rags. Olga was a thin arc, with streamers of dust storm across the dark part. Sally pointed herself at a

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stand of trees some distance beyond this blackened section, and walked fast.

"I take it ye want as much time as possible amidst yon life," Dunbar ventured.

She nodded. "Of course. How long will it remain?"

"Ye're too pessimistic, lass—pardon me—Dr. Jennison. We'll smite the berserker, ne'er fear."

"How can you be sure? It'll be the biggest, most heavily armed, most elaborately computer-brained type they've got. I've seen pictures, read descriptions. It'll not only have a monstrous offensive arsenal, it'll bristle with defenses, forcefields, antimissiles, interceptor beam projectors. Can your few destroyers, or whatever they are, can they hope to prevail against it, let alone keep it from laying—oh—enormous territories waste?"

"I told ye, their main purpose is to lure it to where our ground-based armament can take o'er."

"That seems a crazy gamble. It'll be a moving target, hundreds of kilometers aloft."

"We've no' just abundant energy to apply, we've knowledge o' where to. The layout o' such a ship is well understood, fro' study o' wrecks retrieved after engagements in the past."

Sally bit her lip. "You're assuming the thing is . . . stupid. That it'll sit passive in synchronous orbit, after failing to suspect a trap. Berserkers have outsmarted humans before now."

Dunbar's tone roughened. "Aye, granted. Our computer technology is not yet quite on a par wi' that o' the ancient Frankensteins who first designed them. The monsters do no' behave foreseeably, e'en in statistical fashion, the way less advanced systems do. They learn from experience; they innovate. That's wha's made them mortal dangers. Could we build something comparable—"

"No!" said ingrained fear. "We could never trust it not to turn on us."

"M-m-m . . . common belief . . . Be that as it may, we do lack critical information. Nobody has studied a modern, updated berserker computer, save for fragments o' the hardware. Software, nil. Wha' few times a capture looked imminent, the thing destroyed itsel'." Dunbar's chuckle was harsh. "No' that the weapons employed usually leave much to sweep up."

"And nevertheless you think you can trick one of their top-rated units?"

"They're no' omnipotent, Dr. Jennison. They too are bound by the laws o' physics and the logical requirements o' tactics. Humans ha' more than once defeated them. This will be another occasion."

Ash gave way to turf. "Maybe, maybe," the woman said. "But that's not enough for me. The berserker will fight back. It will employ its most powerful weapons. You've hardened your base, but what have you done to protect the neighborhood? Nothing."

He wilted. "We could no'," he answered in misery. "We know naught about the natives."

"My colleagues do. They'd have undertaken to make arrangements with them."

"Rightly or wrongly, our orders were to clear your team out o' the way immediately and completely, out fro' underfoot, so we could get on wi' our task," Dunbar said shakily. "I hate the

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thought o' losing lives, but wha' we do is necessary to save the whole native species."

The shaw was close. The man's sidearm sat within centimeters of Sally's hand. She felt no excitement, only a vivid sense of everything around her, as she snatched it from its holster and sprang back.

"Oh, no!" she cried. "Stop where you are!"

"Wha's this?" He jerked to a halt, appalled. "Ha' ye gone schizo?"

"Not a move," she said across the meters of living sod. The pistol never wavered in her grip. "At the least suspicion, I'll shoot, and believe me, I'm a damn good shot."

He rallied, mustered composure, said in a flat voice: "Wha' are ye thinking o'? I can scarce believe ye're goodlife."

"No, I'm not," she flung back. "Are you?"

"Hoy? How could ye imagine—"

"Easily. Your story about the berserkers chancing upon Ilya doesn't hang together. The sole explanation for everything I've witnessed is that *you* informed them, you Adamites, you called them in. Dare you deny?"

He swallowed, ran tongue over lips, bowed his head. "We've a trap to spring," he mumbled.

"For a single trophy, you'd set a world at stake? You're as evil as your enemy."

"Sally, Sally, I can no' tell ye—"

"Don't try. I haven't the time to spill, anyway. I'm going to do what you'd never have let me, lead the natives hereabouts to safety . . . if any safety is to be found, after what you've caused. Go back! This instant! I'll kill anyone who tries to follow me."

For a long while he looked at her. The wind soughed in the darkling trees.

"Ye would," he whispered finally. "Ye might ha' asked leave o' the admiral, though."

"Would he have granted it, that fanatic?"

"I can no' tell. Maybe no'."

"It wasn't a risk I could take."

"Fro' your standpoint, true. Ye're a brave and determined person."

"Go!" She aimed the pistol between his eyes and gave the trigger a light pressure.

He nodded. "Farewell," he sighed, and trudged off. She watched him for a minute before she disappeared into the woods.

The deathmoon slipped out of flightspace and accelerated ponderously toward the red sun. Starshine glimmered off the kilometers-wide spheroid that was its hull. The weak light ahead cast shadows past gun turrets, missile tubes, ray projectors, like the shadows of crags and craters on a dead planet.

A radar beam brought word of the double world. The berserker calculated orbits and adjusted its vectors accordingly. Otherwise nothing registered on its receivers but endless cosmic rustlings.

The solar disc waxed, dark spots upon bloody glow. The target globe and companion glimmered as crescents. The berserker was slowing down now, to put itself in a path around the one which was alive.

It passed the other one. Abruptly, detectors thrilled. Engines had awak-

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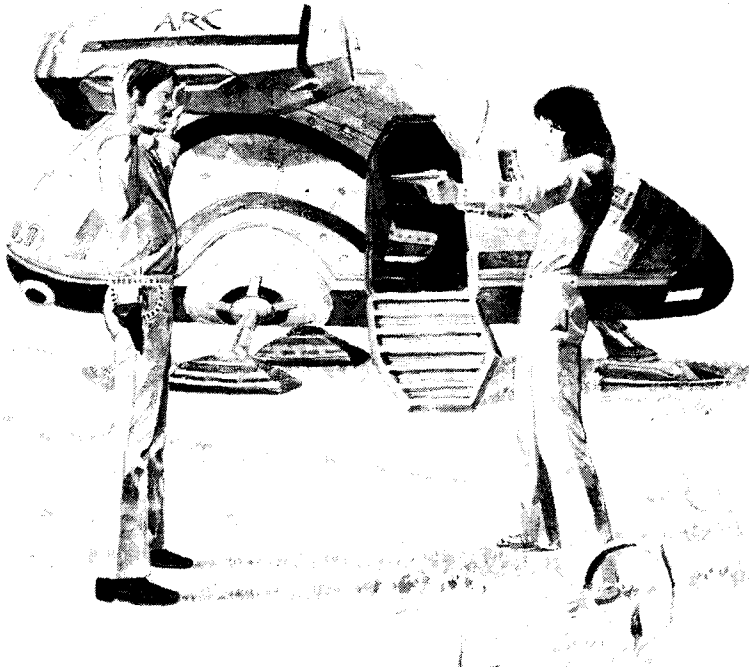

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ened, spacecraft were scrambling from both planets—human vessels.

The berserker tracked them. They numbered half a dozen, and were puny, well-nigh insignificant. Not quite; any could launch a warhead that would leave the berserker a cloud of molten gobbets. However, even attacking together they could not saturate its defenses. It would annihilate their missiles in midcourse, absorb their energy beams, and smash them out of existence, did they choose to fight.

Should it? Within the central computer of the berserker, a logic tree grew and spread. The humans might be present by chance (probability low). If not, they had some scheme, of which the revelation by the Montgomery unit had been a part (probability high). Ought the berserker to withdraw? That might well be the intent of the humans; they often bluffed. The assumption that they were strong in this system would affect strategy, by causing underestimation of their capabilities elsewhere.

The berserker could retreat, to return in an armada invincible against anything the humans might have here. But this would mean postponing attacks elsewhere. It would buy the enemy time he much needed, to bring help from distant sectors. Whole worlds might never get attended to.

Information was necessary. The berserker computed that its optimum course was to proceed. At worst, a single capital unit would perish. It considered dispatching a courier back to base with this message, calculated that the humans would detect and destroy the device before it could enter flightspace, and refrained. Its own failure to report in would warn the others, if that happened.

The berserker moved onward —majestically, a human would have said—under its great imperative, to kill.

First, if possible, it should dispose of the opposing spacecraft. They were widely dispersed, but generally maneuvering near the target mass. Computation, decision: Move their way, seek engagement, meanwhile establish orbit, commence sterilization, lash back at any surviving human vessel which dared try to distract the berserker from its mission.

It swung inward. The little ships did likewise, converging on a volume of space above the terminator. The berserker followed. A destroyer accelerated audaciously forth. The berserker shifted vectors to shorten the range. This brought it near the fringes of atmosphere, at less than orbital speed. Its track curved gradually downward. But the parameters were in its data banks, its drive was already at work to bring it up again, it was simply using gravitation as an aid.

Lightning lanced out of the night below.

Electronically fast, the ship's fire control center reacted. Even as sensors recorded the slash of energy through metal, and went blank before that fury, a missile sprang.

There was only time for the one. Then the berserker tumbled around itself, sliced across. Stars danced about, incandescent drops that had been armor, before they cooled and went black. Radar-guided, light-fast, the beam carved again, and again. Cut free of every con-

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nection, the central computer drifted in its housing amidst the pieces, blind, deaf, dumb, helpless.

The human vessels spurted to salvage the fragments before those could become meteors.

A newly gibbous Olga gleamed red-cold over Snowcrown. Mountains beyond were jagged ramparts under constellations Earth had never seen. In a hollow of the foothills, campfires cast flickery gleams off eyes and eyes, as three hundred or more Ilyans huddled close. They said little, in that enormous silence.

Sally Jennison crouched likewise. She, the alien, her skin bare beneath its garb, needed the most help against gathering chill. Her friends, the leaders of the exodus, squatted to right and left. She could almost feel their questioning.

Rainbow-in-the-Mist uttered it: "How long must we abide, Lady-Who-Seeks? The food we have brought grows scant. The younglings and the old suffer. But well you know this."

"I do," Sally replied. Breath smoked ghost-white from her lips. Hunger made her light-headed; her own rations had given out many hours ago, as she took the Geyserdale folk eastward to shelter. "Better hardship than death."

Feather-softly, he touched her hand. "Yours is the worst case," he fluted. "We would not lose you whom we love. When can everybody turn back?"

"When the danger is past—"

Behind those ridges that barred view of the west, heaven sundered. A sheet of blue-white radiance momentarily shrouded stars and moon. Trees and shadows were as if etched. Ilyans shrieked, flung arms over faces, clutched infants to their bodies. Sally herself stumbled bedazzled.

"Hold fast!" she yelled. "Rainie, tell them to stay brave! We're all alive!"

The ground sent a shudder through her bones. She heard rocks bounce down slopes. The rags of brilliance began to clear from her vision.

She went about among the Ilyans with her lieutenants, helping, reassuring. They had not panicked—that was not in their nature—and although they were more vulnerable to actinic light than she was, it didn't seem that anybody's sight had been permanently damaged; intervening air had blotted up the worst. She wept in her relief.

After minutes the sound arrived, a roar whose echoes cannonaded from hill to hill for what seemed like a long while. But there had been no second hell-flash. Whatever had happened, had happened.

"Is the danger past?" asked Rainbow-in-the-Mist when stillness had returned.

"I . . . think so," Sally answered.

"What next shall we do?"

"Wait here. You can hold out till—oh, dawn. Though if things go well, it should end sooner. My fellow creatures ought to arrive in their vehicles and ferry you back before them."

"Home?"

She disliked admitting: "No, I fear not. Your homes are smashed and burnt, as you yourselves would have been if we'd not fled. It'll be a year or two" —brief Ilyan years—"till you can rebuild. First we'll distribute you among your kindred in the unharmed hinterlands.

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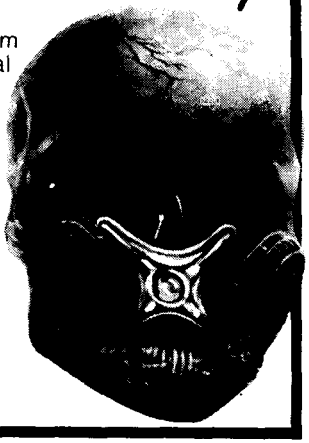
THE LAST GASP

by TREVOR HOYLE



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"But I must go tell the humans. Best I start off at once."

"*We* will," Rainbow-in-the-Mist said. "I've better night vision, and can find things to eat along the way, and . . . would not let you fare alone, Lady-Who-Saved-Us."

She accepted his offer. He would have insisted. Besides, he was right. Without a partner, she might not survive the trek.

Unless, to be sure, the men of Adam came looking for her in their aircars, wearing their light-amplifier goggles.

They did.

"We're unco busy," Admiral Scrymgeour had snapped. "No time for official briefing, debriefing, any such nonsense. Later, later, just to satisfy the bureaucrats. In the interim, Dr. Jennison, now that ye've gotten some sleep and nourishment, I detail Captain Dunbar to explain and discuss. He deserves a rest himsel'." Did he wink an eye?

She had inquired if they might leave the clamor and closeness underground, to talk in peace (if peace was possible between them). Dunbar had agreed. Residual radioactivity wasn't dangerous topside unless exposure was unreasonably prolonged. Warmly clad, they sought the bluff above Lake Sapphire.

Olga stood nearly full, a rosiness on which few scars showed, only dark emblazonings and streamers of brightness that were high-floating clouds. A frost ring surrounded it, and stars. Through windless cold, it cast a nearly perfect glade over the water. Beyond, mountains reared hoar, Snowcrown a faintly tinged white. Ice creaked underfoot,

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almost the single sound. It covered scorched turf, leveled homesteads, trees shattered to kindling, with a glittery blanket. Come sunrise, growth would begin again.

Dunbar spoke softly, as though unwilling to violate the hush: "Ye've naught to fear fro' us, ye realize. True, belike ye'd no' ha' been released on your errand o' mercy if ye'd applied. Overcaution, same as when ye appeared in your boat. Howe'er, ye did break free, and save those many lives. Our consciences are eternally in your debt."

"What about yourself?" she wondered. "You failed in your duty."

He smiled like a boy. "Och, they're glad I did. And in any case, no' to be modest, I carried out my real duty wi' full success. That's wha' matters. The episode wi' ye will simply not get into the record."

She nodded in troubled wise. "You demolished the berserker, yes."

"Wrong!" he exulted. "We did no'. 'Twas the whole point. We captured it."

Her pulse stumbled. She stared at him.

He grew earnest. "We could no' tell ye, or your colleagues, in advance. The attempt might ha' been a failure. If so, we'd want to try afresh elsewhere —different ruse, o' course, but same basic objective. Meanwhile, we could no' ha' risked word about that intention getting out and forewarning the enemy, could we?"

"But now—?" she breathed.

He faced her. Beneath his shadowing hood, eyes shone forth. "Now," he said, "we can make amends to ye, to Ilya. We'll mount guard o'er this world, at least until a gathered alliance can assume the task. No' that I await another attack. When they ne'er hear fro' the ship they sent, the berserkers will likeliest become leery. They've much else they want to do, after all, before they're forced out o' the entire sector."

Compassion touched her. "Including an assault on Adam?"

"Maybe. If so, they'll no' succeed. They may well no' e'en try. The fact that we fooled them should gi' them pause. Be that as it may, we've strength to spare—including our weapons on the ground, and more that we can install roundabout this planet—strength to spare for Ilya." His lips tightened. "We did do its folk a wrong—perforce; in a righteous cause; nonetheless a wrong. We pay our debts, Dr. Jennison."

"But what *was* your cause?" she asked in bewilderment.

"Why, I told ye. To capture intact a first-line berserker unit. No' the actual ship, though study o' the pieces will prove rewarding, but its brain, the principal computer, hardware and software both, before it could destroy itself.

"To that end, we lured a single craft here, where we'd assembled a ray projector. Our weapon has the gigawatts o' power, the lake for cooling, the sheer physical dimensions for precision, that it could dissect a berserker across two or three thousand kilometers."

Her gloved hands caught his. Fingers closed together. "Oh, wonderful!" Her admiration retreated. "Yes, I can see how the data will be very helpful; but can they make that big a difference?"

"They can change everything," he replied.

After a moment, during which breath

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smoked between them, he said slowly: "Ye inquired about von Neumann machines. Ye were correct; that is wha' the berserker fleet is, taken as a whole. A self-reproducing system whose basic program is to seek out and kill all that's alive.

"Well, wha' if we humans created another von Neumann machine, a system whose basic program is to seek out and kill *berserkers?*"

Her response was unthinking, automatic: "I've read something about that. It was tried, early in the war, and didn't work. The berserkers soon learned how to cope with those machines, and wiped them out."

"Aye," he agreed. "The ancient Builders built too well. Our race could no' make computers to match theirs, in scope, flexibility, adaptability, capacity for evolution. We must needs develop living organization, dedication, skill, humans an integral part o' the control loop. And 'tis no' served us badly. We've saved oursel's, most o' the time.

"But . . . there is no end to the war, either. They've the cosmos to draw on for the means o' building more like themsel's."

Sally remembered her image of a womb, and shivered.

"On the basis o' what we're going to learn," she heard Dunbar say, "let us make machines which will be likewise, but whose prey is berserkers."

"Dare we?" she replied. A crack rang loud through midnight as frost split a fallen tree apart. "Might they turn on us also, at last?"

She thought she saw stoicism on his face. "Aye, the old fear. Maybe, on that account alone, humankind will unite to forbid our undertaking.

"Or maybe we'll do it, and 'twill prove no single answer by itsel'. Then at least our hunter machines will bring attrition on the enemy, take pressure off us, help us deliver the final hammerblow.

"And if no' e'en that comes to pass, why, we've still gained information beyond price. Once we've examined our . . . prisoner, we'll understand today's berserkers far better. We'll become able to fight them the more readily."

It blazed from him: "Is that no' worth the risk and cost to Ilya, Sally?"

At once he was abashed. "Forgi' me," he said, while his hands withdrew from hers. "Dr. Jennison."

She regarded him by the icy brilliance. The thought came to her that perhaps robots that hounded robots were nothing to fear. Perhaps dread lay in the fact that a war which went on and on must, ultimately, bring forth men who were as terrible as their enemies.

She didn't know. She wouldn't live long enough to know. She and he were merely two humans, by themselves in a huge and wintry night.

She took a step forward, renewed their handclasp, and said, "We can argue about it later, Ian. But let's be friends." ■

NOTE: *This story is part of a forthcoming book, edited by Fred Saberhagen, to which various writers are contributing. The concept of the berserkers is Fred Saberhagen's, and is used here with his permission.*

● Better late than before anybody has invited you.

Ambrose Bierce

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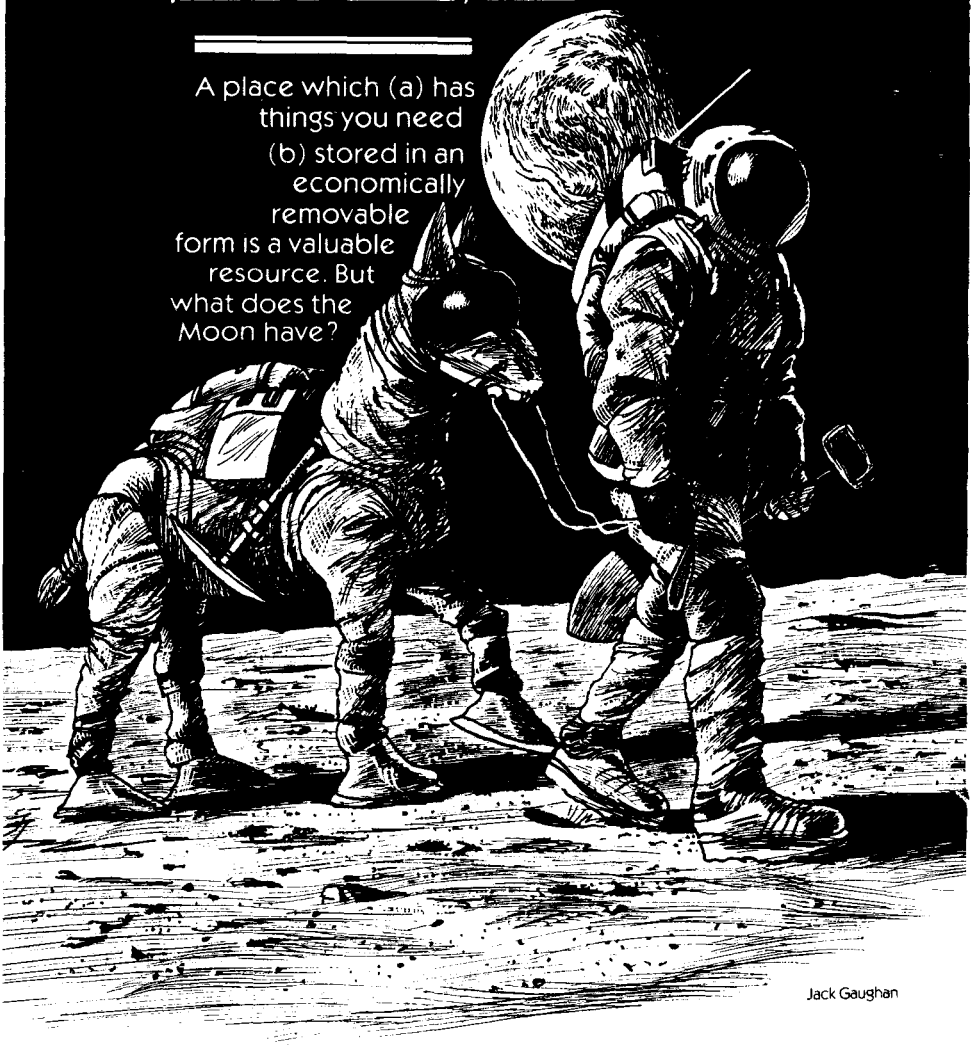
MINING THE MOON

Stephen L. Gillett, Ph.D.

A place which (a) has things you need (b) stored in an economically removable form is a valuable resource. But what does the Moon have?



Jack Gaughan

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Why mine the Moon—or any planet-sized body—at all? They're beset with such inconveniences as deep gravity wells and atmospheres, and you can't do more than scratch the surface; most of the volume of the planet is inaccessible. Oh, sure, we'll build mass drivers on the Moon and scoop up bags of lunar dirt—nothing fancy, we're just looking for common elements. And early in the space industrialization effort we'll have to bring up lots of material from Earth—volatiles (water, chlorine, carbon) and rare metals (copper, moly, vanadium) to supplement the stuff the lunar dirt's deficient in. But ev'body *knows* the asteroids are where it's at, ultimately. They're easy to get to; no gravity well and lots of surface area—you can even move them bodily (at least the little ones). They're also rich in some elements the Moon's crust lacks, particularly the volatile elements: the carbon, hydrogen, and nitrogen for life support and industrial processes.

So goes the emerging conventional wisdom. And, admittedly, there's a lot of truth in it: gravity wells are awkward, and most of the planet is effectively beyond your reach. And atmospheres, if present, are a real drag—you can't even use mass drivers to throw stuff off the surface, but have to get involved with propelled transport vehicles, with attendant hemorrhages in economy. (An apt terrestrial analogy, due to T. A. Heppenheimer, is the difference in cost between moving bulk goods by pipeline versus by airplane.) However, there's a major point to consider before completely writing off planets as economic sources of raw materials.

Planets are *differentiated* bodies (no, Virginia, nothing to do with calculus). "Differentiated," in this context, means chemically and physically differentiated—fractionated, if you will. Consider planetesimals formed from the solar-nebula condensates: blobs of nickel-iron alloy; droplets ("chondrules") of refractory (opposite of "volatile") silicates; low-temperature carbonaceous material. Stir together a heterogeneous, planet-sized mixture of this material (in different proportions, granted; heavier on the metal for Mercury, heavier on the rocky material for Mars; very light on the volatiles for the Moon—but all still mixtures). What happens? Well, first the mixture becomes hot from the energy of gravitational infall and the decay of natural radioactive elements. The planetary body melts, at least in part, and then physically and chemically separates on a planetary scale: the heavy stuff (iron) sinks to the center while the light material (silicates—"slag" and volatile elements) rises to the surface.

Planetary scale chemical differentiation has another consequence: it gives a chance for those parts-per-million (or billion) rare elements to aggregate into more substantial, albeit localized, concentrations. Rare elements can be broadly divided into two types, "dispersed" and "incompatible." Dispersed elements are sufficiently similar in chemistry to a common element that they form no minerals of their own—they are "dispersed," and replace that common element in its minerals. Examples are rubidium (which replaces potassium in potassium minerals), gallium (which follows aluminum), and bromine (which

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follows chlorine). Dispersed elements don't ever become very concentrated in nature; generally, they are recovered as by-products when refining other elements.

Incompatible elements, in contrast, are iconoclasts; they don't fit well into any of the common minerals, but form their own—with important economic consequences. Consider, for example, a cooling mass of magma (molten rock). As it solidifies, the incompatible elements become more and more concentrated in the residual melt; finally, after most of the magma is solid, they become sufficiently concentrated to form their own minerals. The minerals end up as distinct veins in a much larger body of rock.

Now the punchline: most of the familiar metals—gold, copper, tungsten, beryllium, tin, lead; zinc—are incompatible elements. In fact, these metals are familiar, some known since antiquity, because they become concentrated by geologic processes.

Planetary differentiation works the other way, too. On the Earth, for example, a number of elements are much rarer in the crust than their cosmic abundances, because their chemistry is such that they have tended to "partition" (geochemist's jargon; it means "separate into preferentially," which is why "partition" is easier) into the Earth's nickel-iron core. These elements are "siderophile" ("iron-loving," if you've forgotten your Greek); siderophile elements that are greatly depleted in the crust include such valuable commodities as nickel, cobalt, and platinum. To recover these elements, we want a non-differentiated body, like a metallic asteroid—but therein lies another article.

So the large-scale chemical fractionation that accompanies the formation of a planet concentrates incompatible elements in the planet's crust (at least, those incompatible elements that didn't end up in the core instead). But that just sets the stage: planets are huge bodies, and natural radioactive elements in that enormous volume produce a lot of heat over geologic time. As this heat builds up and slowly works its way out, it keeps the planet active for a long, long time. Several things happen. First, rocks at depth "partially" melt; that is, the low-melting fraction becomes liquid, and the bodies of magma so formed work their way upward by buoyancy, like bubbles in a beer. The magmas may either crystallize at depth (and fractionate again while they crystallize), or they may reach the surface to be extruded as lava (and again undergo fractionation). Also a small proportion of the planet's heat gets transformed into mechanical work, or "tectonics" in geologic jargon: uplift, mountain-building, faulting. On the Earth, plate tectonics continually recycles crust. "Plates" are formed as new sea floor oozes out at mid-ocean ridges; they are consumed at "subduction zones," where old sea floor, with an accumulated burden of sediments riding piggyback, plunges back into the mantle at oceanic trenches. The down-going slab of cold rock is in turn heated and partially melted (the lavas and ash of Mt. St. Helens, like all the Cascade volcanoes, are derived from the partial melting of the subducting Juan de Fuca plate thirty or forty kilo-

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meters below the surface). In all this activity the continents are passively rafted back and forth, split up, fused together, eroded, and the sediments subducted, only to be melted and pop back to the surface with igneous activity. A planet like the Earth is a huge chemical fractionating plant.

As you might have gathered from all this, Earth is well set with ore-forming processes. Not only does plate tectonics constantly stir the outermost 100 km or so of our planet, but the Earth's atmosphere and ocean also supply a bewildering variety of fractionation processes. Purely physical separation occurs: placer deposits formed by running water. Chemical separation occurs: compounds precipitated from aqueous solution in the ocean, in sedimentary rock, in lakes, ponds, and marshes. In fact, the interaction between the multitude of geologic processes increases their effectiveness. For example, erosion, a physical process, is a conveyor that continually pours broken, uplifted rock back into the tectonic recycler, and the material becomes further chemically and physically fractionated as it's carried along. The ultimate deposits on the sea floor are then carried down in a subduction zone to be melted and extruded anew. Or sedimentary rock can be chemically (or biologically—much separation is expedited by the activities of living things) pre-enriched in some element; upon being "cooked" by burial, or by an intruded magma, the element can be mobilized and concentrated into distinct veins.

That leads into another aspect of Earth's ore formation: even igneous ore-forming processes (well, many of them) rely on Earth's water. Earthly magmas are generally saturated with H_2O; a silicate melt at hundreds of degrees centigrade can contain a few weight percent water. As the magma cools and solidifies, the incompatible elements accumulate in a water-rich residual melt. Eventually a separate "fluid phase" forms, essentially a dense, superheated steam charged with a host of other elements. This fluid phase can be injected into the "country rock" around the intrusion to cool, segregate, and finally crystallize. The whole sequence describes the genesis of a "hydrothermal deposit," in geologist's lingo, and such deposits are extremely important mechanisms for forming terrestrial ores. Those veins of quartz seamed with gold that you read about in Western novels are the result of hydrothermal processes.

By the way, what is "ore," technically, now that I've started using the word? As defined in the American Geological Institute's *Glossary of Geology* (1978 edition), an "ore" is (a) "The naturally occurring material from which a mineral or minerals of economic value can be extracted at a reasonable profit. Also, the mineral(s) thus extracted. The term is generally but not always used to refer to metalliferous material . . .". Thus "ore" is an economic term—only! If it is an economically useful concentration of (generally) metallic element(s), it is "ore." By definition. The word carries no connotation of the particular geologic process that happened to cause the concentration. We can properly use the word "ore" to describe what we

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mine on the Earth, on the Moon, or anywhere else.

In contrast to the Earth, the Moon doesn't stack up well at all in terms of ore-forming processes. The Moon is nearly—though possibly not completely—dead volcanically; it is airless and waterless; and it is tectonically inert. The crust of the Moon is thick and rigid, not thin and mobile like the Earth's; plate tectonics does not stir the crust continually over geologic time. Finally, more than being just airless and waterless, lunar rocks are drastically depleted in volatile elements—elements, including carbon, hydrogen, chlorine, and nitrogen, that have low boiling points and that on the Earth are concentrated in the ocean and atmosphere. Even metallic elements with low melting or boiling points, such as lead, are much rarer on the Moon.

This lack of volatiles is a double whammy. Not only are many of the volatile elements vital for life support and space industry, they are vital to many ore-forming processes! On the Moon there are no placer deposits, winnowed by running water; no metal-rich precipitates from aqueous solutions in sedimentary rocks; no chemical concentrations by living things. And there are no water-saturated magmas at depth to form hydrothermal ore deposits by injecting metal-laden juices into the country rock.

Still, things are not completely bleak. First of all, that first-order separation from the planetwide differentiation itself has already yielded benefits. In the lunar highlands, or "terrae," the light-colored, heavily cratered ancient terrane* that comprises most of the Moon's surface, calcium and aluminum have been concentrated into the mineral anorthite, $CaAl_2Si_2O_8$. Large parts of the highlands are dominantly anorthosite, a rock composed mainly of plagioclase (anorthite is pure calcium plagioclase; "plagioclase," in case we caught you by surprise, is sodium-calcium feldspar, (Na, Ca)(Si, Al) $AlSi_2O_8$. Most lunar plagioclase is nearly pure anorthite). Both Ca and Al are not particularly abundant in asteroidal material—the lunar highlands are a much richer source. And Al in particular is a very useful industrial metal.

The lunar lowlands, or "maria,"** are also enriched usefully. The maria are plains composed of thick sequences of flows of basalt, a dark lava that is also common on Earth (similar basalts comprise the Hawaiian Islands, the Columbia Plateau in Washington state, the cinder cone Sunset Crater in Arizona, most of the sea floors, and so forth). Many of the mare basalts contain a few percent titanium, a useful metal that isn't especially abundant otherwise.

The mare basalts are the result of the Moon's continuing evolution as a planet after its formation; they are "early secondary differentiates," magmas formed by the partial melting of rock deep

That's the spelling used by geologists in the sense of a "general geologic region."

***MAH-ree-uh, not like the name "Maria." The word is Latin, the plural of mare (MAH-reh), "sea"—from Galileo's belief that the dark, smooth lowland areas were seas.*

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within the Moon's crust long after the Moon had formed. The mare flows are not spring chickens even by geologic standards; they range in age from about 4 billion years to as young (!) as perhaps 2.5 billion. Still, the Moon formed at about 4.6 billion years ago; 600 million years elapsed before mare basalts began erupting. That's a substantial delay; for comparison, 600 million years ago trilobites had just begun swimming in Earth oceans. (The age dates on the mare basalts are obtained two ways. Some come from determinations, on returned samples from Apollo or Luna spacecraft, of the amount of "daughter" nuclei resulting from the decay of long-lived, naturally occurring radioactive elements. Other age estimates are made from the relative abundances of impact craters on the surfaces of the basalt flows.)

In passing, I'll note that the Moon's surface has yet another advantage for mining: it has been pervasively broken up by eons of meteorite impact. The lunar regolith (not "soil"—all soils are regoliths but not vice versa) that has resulted from this comminution is already halfway to being an industrial feedstock. It still needs sieving for size sorting, but most of the milling has been done. And milling is expensive.

All right already. The Moon is a good source of aluminum and titanium because it is a differentiated body. The surface rocks have even been broken up, so that they're easy to push with a 'dozer and scoop onto a conveyor belt. But I've reviewed how the Earth is a far better fractionating plant than the Moon; can there really be any ores of rare elements?

Before speculating on the sorts of ores that may occur on the Moon, let's review the "wish list" for industry in space. The useful elements that are readily available on the Moon are (first and foremost) oxygen, followed by silicon, and then the structural metals iron, magnesium, aluminum, and titanium. In addition, manganese and chromium can probably be recovered as by-products without too much trouble. But what else do we need? Well, first off, there are the volatiles: water, carbon, and nitrogen for life support; carbon and chlorine for carbochlorination, to smelt silicates into free metal and oxygen; water for industrial processes; sulfur for sulfuric acid. Then there are the other industrial metals, which read like a Who's Who of the periodic table: Copper. Zinc. Zirconium. Vanadium. Molybdenum (generally affectionately shortened to "moly"). Tungsten. Lead. Beryllium. Chromium. Tin. Niobium (I refuse to say "columbium"!). Even gold and silver. Many of these metals (Cr, Mo, V, Nb) are critical in various steel alloys; some (e.g., Zn) are useful for alloying aluminum; a few are useful in themselves (copper for electrical conductors; tungsten for electrical filaments), and yet others are primarily useful in their compounds (Ag in photography).

To me, holding this shopping list, it looks as if there are three strategies for approaching the search for lunar ores. First and most straightforwardly, we can simply look for exceptionally concentrated deposits of the common elements—nearly pure anorthite, for example, or concentrations of ilmenite (the iron-titanium oxide that is the ore mineral for titanium). This sort of exploration will ultimately be valuable,

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but it will not be important early in the lunar exploitation effort. The location of a mass driver for sending material off the Moon is dictated by celestial mechanics; certain locations are favored because they lead to achromatic trajectories, trajectories whose endpoints are not sensitive to small errors in launch directions or velocities. Achromatic trajectories are extremely important to the economics of the lunar mass drivers, because both the mass driver and the mass catcher (in space) can be simpler and therefore cheaper. Thus any lunar ore will have to be sufficiently valuable, because of either concentration or composition, to warrant transporting the ore to the mass driver. Even exceptional concentrations of the common elements won't qualify at first.

(Transportation of ore to the mass driver won't be terribly difficult; small mass drivers, "mass throwers," will work nicely for tossing the material around on the Moon. You don't need ore cars, because in an airless environment you can count on ballistic trajectories. However, the additional expense of a separate mining base with a mass thrower must be justified by the value of the material mined.)

Second, we could look for anomalous concentrations of elements that are rare on the Moon but are not particularly rare cosmically. The volatiles fall in this category. For example, there may be deposits of water ice in permanently shadowed "cold traps" near the lunar poles. (The result of a possible lunar ore-forming process that has no counterpart on Earth! Amazing!) Such deposits can be legitimately considered "ores," according to the definition I quoted earlier; they may be worth seeking because the Moon is nearby and convenient. It may turn out, however, that the asteroids are just as convenient as a source of volatiles. Perhaps lunar volatiles will be most economical for the lunar settlements.

Probably the most useful prospecting to carry out on the Moon is to search for industrially important elements that are just *rare*. In this way we are exploiting the Moon's great advantage; that it is a planet-sized body that has undergone large-scale chemical differentiation. Concentrated deposits of such elements would be extremely valuable even early in the lunar exploration effort; and in the slightly longer run, by establishing sources of raw materials that are completely independent of the Earth, such deposits may be critical.

With no water on the Moon, many sorts of sedimentary ore-forming processes are out. As I've mentioned, too, hydrothermal processes like Earth's are hampered or precluded by the dearth of H_2O. However, although the Moon is depleted in volatiles, some are still present.

Sulfur, for example, is depleted but extant, and sulfide minerals are accessories (trace constituents) in many lunar rocks. Sulfur is a relatively "electronegative" element, which means it tends to preferentially combine with metals; thus, some sulfur has remained on the Moon in the form of sulfides. In addition, by happy chance most of our wishlist deficient metals are "chalcophile" (more jargon—"sulfur loving"); that is, given their druthers they will combine in sulfides rather than silicates. Furthermore, molten sulfide and molten

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silicate together in a magma separate into "immiscible liquids," like oil and water, and the droplets of sulfide in the silicate melt scavenge most of the chalcophile elements. A number of important ore deposits on the Earth have been formed in this way.

Chlorine is another important element that, although relatively volatile, is electronegative and should have been retained to some degree on the Moon in metallic salts. Indeed, chlorine may become concentrated with sulfur in a late fluid phase in a cooling magma. Such a late vapor phase, the "juices" exuded by a cooling magma, would be analogous in both geochemical and economic significance to Earth's hydrothermal fluids; although "hydro"-thermal, in this case, is something of a misnomer. Chlorine should also form water-soluble salts—this should make leaching the ore a simple procedure!

Sulfide or chloro-sulfide enrichment is not the only possible lunar ore-forming process I can envision, however. Some important incompatible elements are "lithophile" ("rock-loving," this time—they like silicates best). One such metal is beryllium. It is extremely refractory, so it should not be particularly depleted on the Moon; however, beryllium is also an extremely rare element cosmically, because its nucleus is destroyed easily in stellar nuclear reactions. Zirconium is another incompatible, refractory, lithophile element which is relatively rare, and which makes dandy alloys. Beryllium tends to occur mainly in the silicate mineral beryl (whose gem forms are emerald and aquamarine), whereas zirconium mostly occurs in zircon, another silicate. A highly differentiated silicate rock—a granite, say—that contained a few percent of beryl and/or zircon would be a nice ore.

Yet another possible lunar ore-forming process is the formation of "cumulate" deposits, an igneous process that doesn't depend on a late fluid phase separating from the cooling magma. Cumulates are formed in a large body of cooling magma; as the magma cools and crystallizes, heavy minerals can crystallize out and then sink through the melt to rest on the floor of the magma chamber. In some cases, a single mineral will become stable all at once in the cooling magma, forming a distinct "sedimentary" layer when it settles out. Most of the Earth's chromium deposits are cumulates; perhaps similar deposits occur on the Moon.

Well, by just "waving my arms," using elementary geochemistry and our limited information on the Moon, I can hypothesize some reasonable lunar ore-forming mechanisms. Some of the processes may not work out, for one reason or another; but there are probably some processes I haven't thought of that do.

How do we go about prospecting for ores? Another advantage of the Earth's active tectonics is that ores formed by processes occurring deep in the crust have a reasonable chance of being made accessible by later uplift and erosion. Although such uplift does not occur on the Moon (at least in the last four billion years or so, but we may have a pleasant surprise when we investigate the ancient highlands in detail), excavation by impacts—especially very large impacts—furnishes a fair substitute. Craters

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truncate and expose geologic features, and the impact lofts out material from deep in the crust.

In fact, the excavation by impact provides a means for prospecting. When a meteoroid strikes at speeds of tens of kilometers per second, a small fraction of the material splashed out—the ejecta—is thrown for tens, hundreds, or thousands of kilometers, or even reaches escape velocity and leaves the Moon completely. That small, very high velocity fraction from any cratering event lends every lunar regolith an "exotic" component: a few percent of the dirt comes from over a hundred kilometers away; a tiny proportion comes from halfway around the Moon. Analysis of these exotic components yields information on the composition of distant parts of the Moon; Nature has provided us with a remote sampling mechanism.

Such analysis has already provided information on unsampled areas of the Moon. It was surmised very early in the Apollo program, for example, that the lunar highlands are much richer in plagioclase than the maria; this was subsequently confirmed by the Apollo landings at highland sites. A rock type nicknamed KREEP also was inferred from the exotic components in the regolith, and also has subsequently been found. (That's an amazing acronym, by the way, possible only in a linguistic hodgepodge like English; it stands for potassium (whose chemical symbol is K, from *kalium*), *R*are *E*arth *E*lements, and *P*hosphorus. KREEP material is somewhat enriched in those elements.) Finally, just recently a fragment of granite has been found in one of the breccias (rocks comprised of broken bits of other rock) returned by the Apollo missions. Somewhere, thar's granite on the Moon. And granite is a lithophile rock that results from extreme chemical differentiation. On the Earth granites are fairly commonly associated with ores (remember beryllium and zirconium?).

Not only can we determine what other rocks exist on the Moon from analysis of the exotic component in lunar regolith, we can even locate the general area where the rocks occur. Sampling the regolith at a number of different sites will allow us to triangulate back to the source of the exotic component (this will be easier when we have the maps I describe below, which will be made by remote sensing from low orbit). This "backtracking" is no different from what terrestrial prospectors and field geologists do already. When beginning field work, you always inspect the "float," the broken rock that has been brought downslope and downstream by erosion, to determine the rock types that occur upstream. Saves a lot of walking! And a prospector, when he finds "color" in a stream, will continue panning upstream until the color vanishes. He has then located where the gold entered the stream, and he now starts exploring the slopes on either side for the source.

Probably, ore deposits such as I describe in this article will generally be too small to be detected directly by remote sensing. You've simply got to get on the surface and take samples. However, detailed mapping by remote sensing will give us a much better under-

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standing of the Moon's geology* than we have now, and will allow us to locate geologic provinces where ore deposits might be favored. Mineral exploration is also done this way on the Earth; you define a favorable area (according to some geologic model—and different areas can become favorable as different models come into vogue!) and then start looking.

After my spiel several paragraphs ago on the value of the "exotic component" in the regolith, you may wonder how remote sensing could be of any use on the Moon. Hasn't the regolith been hopelessly homogenized by meteorite impact? Not quite; the bulk of the ejecta from an impact doesn't move very far at all. Over 90% of the dirt sitting on top the lunar surface is the broken-up, pulverized, and agglutinated equivalent of the bedrock underneath. This fact makes remote sensing of the lunar surface feasible.

In fact, orbital remote sensing of the Moon will be easier than the Earth in at least one respect: the absence of an atmosphere allows you to get much closer to the surface. For example, "potential fields" techniques are commonly used in geophysical exploration on Earth. In these techniques, you detect minute variations in the Earth's gravitational or magnetic field and use these variations to infer geologic structure. Different rock types cause such variations by their differences in density or magnetic properties. Because of the high resolution required, potential-field surveys on Earth must be airborne or ground-based, and are therefore expensive. On the Moon we can sense potential fields directly from orbit.

Lacking this more detailed geologic mapping, and the more detailed understanding that will come with it, what areas merit prospecting at this point? Several come to my mind. First, a number of features on the Moon have been interpreted as volcanoes. This interpretation is based solely on their detailed morphology, not on sampling; if the interpretation is correct, they represent a different style of volcanism than the mare basalts. Therefore the lavas making up the volcanoes probably differ in composition from mare basalt, and they may be more differentiated. At least they'll be differently differentiated. Such a volcano laid open by a large impact would be a very interesting place to look for veins of minerals.

In a somewhat similar vein (!), "lunar transient events," possibly due to volcanism, have been reported from time to time, and they are still unexplained. The most notorious events have been associated with the central peak in the crater Alphonsus, where spectrograms taken in the '50s suggested gaseous emissions. Perhaps the Moon's volcanism is not quite dead even now. Perhaps, even, volatile emissions accompany this volcanism. For economic as well as scientific interest, Alphonsus should be investigated as soon as we return to the Moon.

Finally, the lunar highlands are an ancient (>four billion years), heavily

*Not "selenology." "Geology" (also "geophysics," "geochemistry," etc., have, quite sensibly, been generalized to all planets, not just the Earth.

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cratered terrane that is certainly far more complex in detail than we currently understand. Sure, by and large the highlands rocks are anorthosite (or norite, or troctolite—two other plagioclase-rich rock types), but there's at least some granite out there, and there might also be large igneous bodies with compositions that lead to cumulate deposits. Additionally, the highlands have been thoroughly shattered by major impacts (and I mean major—craters hundreds of kilometers across), and these rocks were emplaced when the Moon was still highly active volcanically. Many mineralized districts on the Earth contain thoroughly shattered rock (shattered by faulting, in the terrestrial case) which has hosted mineralization because it is riddled with conduits for ore-forming solutions intruded later. What sorts of rare rock types have been emplaced here and there in the highlands? What veins of ore may seam the bedrock?

We really ought to go and see. ■

ABOUT THE AUTHOR

After receiving a B.S. and M.S. from Caltech, Dr. Stephen L. Gillett spent two years with the U.S. Geological Survey in Flagstaff, Arizona, before returning to get his Ph.D., also in geology, at the State University of New York at Stony Brook. Gillett's major research interest has been in applying paleomagnetism—the record of the Earth's magnetic field over geologic history—to the solution of geologic problems. He states that his research work has been on an interface between geology, geophysics, and geochemistry; it is exciting, he says, to see how many different disciplines converge to help understand a gigantic, ancient, fearsomely complex physical system—the Earth. Steve also has a long-standing interest in planetary sciences, and this article is one result of this interest. He says, "A friend who is an astronomer once told me, 'The planets have changed hands in the last thirty years—they're now the domain of earth (!) scientists.' " After a stint with a small geophysical consulting firm in the Seattle area, Steve is now an independent geological consultant.

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● A pig on a mountain sees more than a wise man with a bag over his head.

MaryJane DeFroscia

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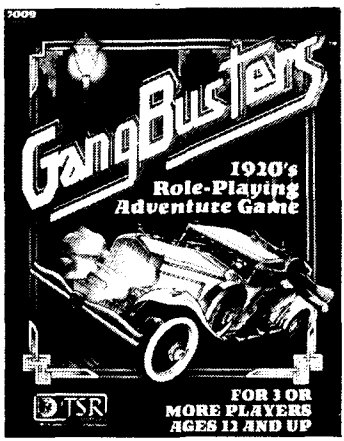

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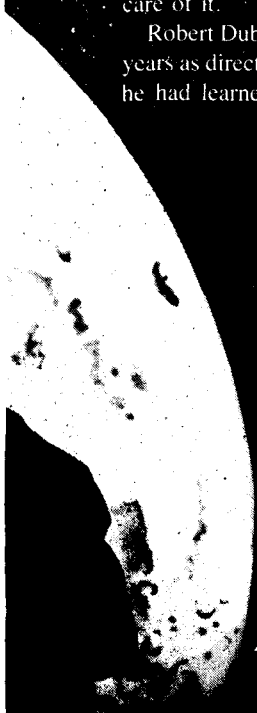

W.R. Thompson

Does the saying "Set a thief to catch a thief" apply to psychologists, too?

Brian Stableford

"I've got a problem here, Bob." Helen Esterhazy's voice buzzed out of the tiny office's intercom. "You'll have to take care of it."

Robert Dubois sighed noisily. In five years as director of the lunar settlement, he had learned that he never saw any simple problems. The easy ones were always handled by the people who encountered them, while he was left with the tough ones. The troubles which ended up in his lap seldom had an answer which pleased everyone. "What is it?" he asked.

"It's that damned psychologist, Hacker," she said. "He's driving me crazy."

Bob shook his head. A week earlier, NASA had sent up a team of research psychologists to study the workings of the colony. Since their arrival they had made nuisances of themselves: aggravating people, getting in the way, and disrupting work schedules. Bob had heard plenty of complaints about them.

He felt that he had more important things to worry about. It was budget time again, and his department heads were pressing him for priorities in materials, manpower, and money. There were plans to expand the spaceport, the living facilities, the lunar-survey operations, and almost every other aspect of the colony. The merits of each plan were obvious, but NASA didn't have the financial resources to go ahead with everything at once. Earthside politicians still gave space a low priority.

Idiots, he thought, glancing at a report on his desk. The asteroid mining project was doing well, and the fusion-drive QuadJets had already towed some small asteroids into lunar orbit. Analysis

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showed that the captive asteroids were rich in chromium, cobalt, vanadium, and a dozen other metals which were in short supply on Earth. Once the orbital refineries were set up, however, the shortages would be over. Anybody could see the effect that would have on the American economy, Bob thought, but he still had to beg Washington to keep the money flowing. He wondered if they were knuckling under to the intense propaganda which flowed from Moscow and Pretoria.

I'm just stalling, he told himself. "Helen, you know the situation. NASA told me that this Hacker has pull in Washington. If we make him too unhappy he'll be lobbying against us. So put up with him. He'll be gone in another week."

"He'll be gone a lot sooner if I catch him in my files again," Helen said darkly. "Listen, Bob, you're going to have to talk with him. He won't listen to me."

"Okay. At least it'll get me out of the office. Give me five minutes. And Helen, don't worry if he drives you crazy. NASA sent us plenty of psychologists."

The lunar colony was large, but not roomy. As Bob stepped into the corridor outside his office he was reminded of a submarine's interior. Pipes, lines, and conduits had been strung where convenient, and various types of emergency equipment were spotted at strategic locations. Ten thousand people lived in a dozen similar levels of decks, corridors, and compartments, buried under the Mare Imbrium.

The hospital facility was placed next to the spaceport, a half-kilometer from Bob's office. Bob reached the clinic in time to hear his chief surgeon bellow, "I don't care *who* you are! Nobody goes grubbing through my files like that!" He followed the roar into Helen Esterhazy's office—a cubicle like his own, crowded with books, furnishings, and a computer terminal. Helen looked at Bob as he entered her office. "Tell me," she snapped. "Am I or am I not in charge of this place?"

"You sure are," he said. "Now what's the problem?"

Hacker cleared his throat. "Miss Esterhazy, here, doesn't feel I'm being reasonable. I just need a little information from her files for my work."

"A little information, hell." Helen held up a memory cartridge. "I walked in here just in time to catch him recording all my files. They're *supposed* to be private!"

"Don't you have them passworded?" Bob asked.

"I never had a reason for that," she said. "My office computer isn't tapped into the main system—and most people respect privacy." She glared at Hacker.

"I'm not invading anyone's privacy," Hacker argued smoothly. "I'm a medical man myself; I have ethics too. And I do have a valid reason for examining your files. I need the psychological profiles on you colonists."

"Let's step outside for a minute," Bob said. He caught Helen's eye, saw her nod. Hacker followed Bob out into the corridor.

"Doctor Esterhazy is in charge of this facility," Bob said. "What she says, goes."

"I quite understand that, of course," Hacker said. "All I'm asking is the

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chance to collect some important information. Can't you order her to cooperate with me?''

''No,'' Bob said bluntly. ''I'm not an absolute monarch—my position is more 'first among equals' than anything else. The most I can do is to ask her to cooperate. If you can convince me that you have to look into her files, I'll ask her to help out—but on her conditions.''

''Oh, yes, absolutely. That's quite fair. What do you want to know about my work?'' Hacker shook his head. ''Silly question. You want to know what I expect to find in the files, of course. Well, I'm looking for signs of stress-generated dysfunctions.''

''You mean things like fatigue, nervous breakdowns and burnouts? Why not just ask Helen about it?''

''I'm not looking for anything so extreme. Psychology isn't her field of competence, but I expect she could have diagnosed such things if she saw them. What I'm looking for—'' Hacker pursed his lips. ''It's rather difficult to explain to a layman. I'm interested in studying the effects of stress on the colony as a whole. You realize how dangerously tense things are up here, don't you?''

Bob looked puzzled. ''What do you mean?''

''I mean that this is the most stress-filled environment in which humans have ever attempted to live. The Moon is almost actively hostile to life. You colonists have to live in an entirely artificial environment, which is very susceptible to failure—I don't need to enumerate the hazards of lunar life; I'm certain you're far more familiar with them than I am. All of you colonists are aware of them—you can't help but be faced with them.'' He gestured at a wall locker labelled EMERGENCY PRESSURE SUITS. ''But I see that you're not aware of how much tension this creates.

''Consider. Everybody here knows that there is a certain probability, however small, that there will be a catastrophe of some sort, some day. Eventually somebody is bound to press the wrong button and leave the colony without power, for example, or a fuel line in the spaceport will rupture and contaminate the air system with hydrazine. Even if you make the happy assumption that there will never, ever be a serious human or mechanical failure, there's always the danger of a giant meteor strike, or some equally deadly natural event.

''So you go to bed not knowing, deep inside, if somebody won't make a blunder which kills you in your sleep. The man who installs a new pressure bulkhead must wonder if he's done everything just right, and if there isn't some hidden flaw in the materials he's using. The man who programs a control computer finds himself wondering if he didn't program in some simple, deadly error. And so on.

''The tension felt by an Earthside reactor technician or air-traffic controller is nothing compared to the stress experienced every day by the average colonist. Controllers know that one split-second error on their part could kill hundreds or thousands in a crash, and reactor techs know that one accident could contaminate vast areas.'' Hacker shook his head again. ''It's no wonder that these two professions have such high incidents of mental illness. And they have the advantage of knowing that

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they can quit at any time, or at least go home at the end of a shift. You colonists don't have that sort of relief."

"Wait a minute." Bob felt the suspicion in his voice. "I've been here since the beginning. *I* don't feel any tension."

Hacker nodded. "Without meaning to be facile, that's exactly what I expect. For one thing, you colonists are very enthusiastic about this experiment of living on the Moon. That does serve as an anodyne to the tension. Furthermore, just because you're not aware of the tension doesn't mean that it isn't there. You're aware of it on a nonconscious level, and it influences you there. I'd say that so far enthusiasm and luck have worked in favor of you colonists, and kept you from becoming conscious of the tension, but that's beginning to break down."

Bob felt a crawling sensation along his spine. "What do you mean?"

"I've noticed quite a few things which wouldn't seem important to a layman such as yourself, but which are quite telling to an expert." He scratched his chin. "For example, there's your own blindness to the tension. It's a widespread condition, I'm afraid. I can't even get the average colonist to discuss it seriously; the aversion to facing the, ah, inescapability of overwhelming danger is too strong to permit much consideration of it. The denial is an escape mechanism, and an unhealthy one.

"Next, I've found no significant use of liquor or recreational pharmaceuticals up here. Oh, people have parties and get-togethers, but they just don't get free."

" 'Free'?" Bob asked.

"Stoned. Drunk. Intoxicated." Hacker smiled. "You see? There's so little use of drugs up here that the slang terms are unknown—and please don't tell me that this is because you people are 'isolated' from Earth. You aren't; there is plenty of contact. This tells me that people here are afraid to relax. Oh, they rationalize it, make a virtue of it, but the truth is they're scared to be left helpless in an emergency.

"Then there are your marriage customs. I've found that men and women up here make heavy use of psychological counselling before they get married. Now, that seems like a good idea, it prevents matches between mismatched people, but it's really another danger sign. It shows an excessive concern with caution. A bad marriage can be fixed with a divorce—but people up here are unwilling to risk a problem as trivial as that. Even a small personal disaster scares them; they only marry if it's a sure thing.

"Look at the use of jargon," Hacker continued. "Have you notices the way that it slips into everyday use?"

"That happens everywhere, doesn't it?"

"Yes, but that doesn't reduce its significance. I've overheard romantic conversations that sounded more like engineering discussions." He grinned sheepishly. "I'm afraid that snooping is an occupational hazard among us psychologists. Well, here a seduction is a 'rendezvous and docking.' People here 'power down' to sleep, 'purge wastes' when they go to the can, and so on. It's all a nonconscious attempt to identify yourselves with machines, which are

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better equipped to survive in the lunar environment, and which aren't prone to human weaknesses.

"As I said, you colonists are beginning to succumb to the stress of living here. You can expect to see increasingly aberrant behavior as time passes. Some people will react to the tension by becoming withdrawn, unresponsive to their surroundings; they might not respond at all to an emergency, in the end. Others will cope by slipping into a fantasy world, and they'll commit destructive acts—such as opening a hatch to let in some fresh air—without realizing that they've done something deadly."

Bob hardly heard him. The colony was doomed, he realized, if what Hacker said was true. "Is there anything we can do about it?"

" 'Do'?" Hacker shrugged. "You could try to soften up this place, make it less harsh, more livable. That would alleviate some of the tension, but not all of it—you people are too intelligent to be fooled for long by cosmetic touches. You might put some psychiatric 'watchdogs' on duty; they could spot most of the dysfunctionals before they caused trouble."

"But not all of them."

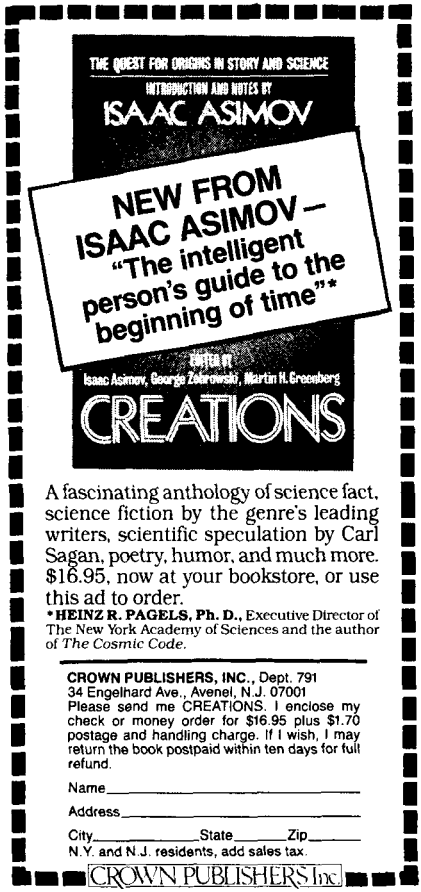
"No, of course not. Every butterfly net has its holes, I'm afraid. No, the only real alternative I can see is for you people to come back home to Earth, before your luck runs out. I realize that doesn't appeal to you, because you colonists have all sorts of glorious plans, but—"

The clinic door opened and Helen stepped into the corridor. "Doctor?" She smiled sweetly. "If you'd care to use my computer, please be my guest."

"Why, thank you." Hacker nodded courteously and ducked into the clinic.

"Did you password your files?" Bob asked, as they headed down the corridor.

"No. I don't know all that much about programming computers, so I just erased everything." Helen laughed at the shocked look on his face, and held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up the memory cartridge she had taken from Hacker. "It's all right in here, and I'll load it back into the machine when he goes away." She slipped the cartridge into a coverall pocket.

"Good job. Helen, how much do you know about Hacker? How good is he?"

"He's rude, arrogant, conceited, chauvinistic, and a talented enemy-maker." She shrugged. "He's also one of the best psychologists there is, and he's no fool. You're worried about what he said, aren't you?"

"You heard him?"

Helen nodded. "Snooping's an occupational hazard, besides being fun."

"I bet. Helen, as this world's foremost expert on psychology, do you think there's anything to what he said?"

"Well . . ." She chewed a knuckle. "Like he told you, psychology isn't really my field, outside of a few practical applications. I haven't noticed anything worrisome . . . but then I wouldn't." She grimaced. "Maybe that's why NASA let him come up here. We're too gung-ho about this place to think that there might be anything basically wrong with it. Hacker's critical of the whole man-in-space concept, though, so at least he's suited for spotting its flaws."

"So he could be right," Bob said. It was a creepy thing, he told himself. Radiation, vacuum, and bureaucratic bungling from Earth were tangible hazards which he had learned to handle. But what can I do about something like this? he wondered. There must be *some* answer!

"He *might* be right," Helen said. "But he could be wrong, too. There's no question that stress is dangerous. Shell shock is the classic example. On the other hand, psychology isn't an exact science—it isn't even exactly a science. I'll get on it at once. Maybe he overestimates the level of tension, or its overall impact. Maybe there are steps we can take."

"All those maybes don't do much for my confidence, Helen."

"I suppose not," she agreed. "But I know you're not happy unless you have something to worry about. That's probably why you're so good at your job. Can we talk about something more important now? Have you finalized the quarterly budget?"

"Yes. I was working on the final draft when you called me. And before you ask, your new body-scanner is in it. It's scheduled for delivery in mid-April."

"Good!" She laughed lightly. "I'm perfectly confident that we'll be here then, and that I'll use it for many years. Satisfied? How's that for confi—"

A loud whistle interrupted her. Bob turned and saw Scott Clements, the spaceport director, bounding down the corridor towards them, a sheaf of papers clutched in one hand. *There's going to be another argument over the budget,* Bob warned himself. Both Helen and Scott put a lot of energy into their wrangling over budgetary priorities, and as Scott drew closer Bob found himself thinking of two hemispheres of uranium, being brought to critical mass.

"I was afraid I wouldn't find you before you sent the new budget requests Earthside," Scott said. He handed the papers to Bob. "I know this is awful sudden, but it's important. You told me last week that we could have the asteroid

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mining project going full tilt in six months, if we concentrated everything on it."

"We could," Bob said. "The processing equipment is ready and waiting at the Cape. The only bottleneck is the number of shuttle launches allocated to us. We have to stand in line for space behind the military and commercial groups."

"I know," Scott said. "Too bad they won't let us use fusion drives in the atmosphere. That'd fix things real fast—well, never mind." He seemed to take a deep breath, as if in preparation for some plunge. "I've talked this over with my crew. If you really can get the mining project rolling in six months, well, we can wait for those two new landers. Use our space on the shuttles to haul up some mining gear. Everybody agrees it'd be worthwhile."

The doctor reached out to touch his forehead. "Are you all right?" she asked.

"I'm fine," Scott said. "I know what I'm saying. Bob, remember that you asked me why both the Russians and the South Africans were propagandizing against the asteroid project, and I said I couldn't guess? Well, I've got the answer now." He gestured at the papers he had given Bob.

Bob unfolded them, and saw that they were computer printouts. "What have you got here?"

"Well, the first page shows the Soviet and South African production figures for manganese, chromium, vanadium, cobalt, palladium, and so on —you know, the 'strategic metals,' the ones that industries must have and can't get anywhere else—on Earth. The next couple of pages show the amount of cash that Ivan and Johnny Boer rake in every year, as estimated by the CIA—"

Helen peered over Bob's shoulder at the figures, and hissed through her teeth. "Bandits."

"I'll say," Scott agreed heartily. "They form a *de facto* cartel that makes the old OPEC consortium look like a charity. Well, the next few pages deal with projections for output from asteroid mining, requirements for personnel and equipment, supplies, general maintenance, and estimated total expenses versus profits. As you can see—" he jabbed the paper with a finger— "we can extract more strategics from the asteroids than all the mines on Earth can produce—and resource depletion being what it is down there, we can undersell Earthside prices and still make a profit."

"You mean corner the market," Helen breathed. "Can those figures be right? It looks like Russia and South Africa earn two-thirds of their foreign currency by selling minerals."

"They do, these days," Scott assented. "They're that important. Think of it—the two biggest tyrannies on Earth, and *we* are in a position to chop out their biggest source of revenue. That ought to hurt them!"

"No wonder they've been screaming," Bob said. "But you know we'll never see a dime of the cash this project makes. NASA may be setting it up, but once it's operational it has to be turned into a private corporation—"

"Like the Comsat Corporation," Scott said. "Or the Skyfac and Orbmech consortiums, with the orbital factories."

"Big deal," Helen muttered. "It's still beautiful, I love it. Bob, if it's true,

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I guess my department can make a contribution to the cause. We can wait for that new scanner. I'm going back to the clinic now—I have some unfinished business. Catch you later." She left.

Bob looked over the papers again. The figures all seemed accurate enough . . . But Hacker cast a shadow over the excitement he felt. Hacker *had* to be wrong, Bob told himself, or this idea would die a-borning.

"Something wrong?" Scott asked. "I quintuple-checked those numbers."

"Oh, they're fine," Bob said. "I'm just preoccupied. Scott, have you run into Dr. Hacker yet?"

"Is he the problem? I haven't met up with him yet, but I've tripped over his two little elves. Want to hear my story?"

"Only if it's funny," Bob told him. "I've already heard plenty about them."

"I can imagine. Well, his two assistants tried to interview me yesterday. I'm telling you, Bob, I felt like I was talking with beings from another planet."

Bob chuckled. "I think maybe you were. What did they do?"

"They just kept asking the damnedest questions, and they kept acting like my answers were the weirdest things they'd ever heard. They wanted to know things like how often I got drunk." He laughed. "I couldn't convince them I didn't."

"Really?" That caught Bob's attention. Maybe there's a key here, he thought. "Just what did they say about that?"

"They started asking me if I was afraid to get drunk, if I thought I might be endangering myself if I did—garbage like that." He shrugged.

"That sounds just like Hacker," Bob said. "Go on, will you?"

"I told them I didn't see any good reason to get bombed, and when I got to a party I get one drink and sip it. Back Earthside I used to party-hearty, but now . . ." He seemed to grope for words. "Well, it seems a shame to get together with people I like, and then get so lushed I can't notice them. I mean, that seems almost insulting—like they're not real friends, just folk you'd want to avoid."

"I think I see," Bob nodded. "And how did they like that?"

"The two of them got this smug, superior look, and one of them said I didn't understand my own motivations." He laughed again. "He said I at least ought to study some basic psychology. The jerk even suggested some books—ones that this Hacker wrote. That figures, doesn't it?"

Bob's eyebrows arched up. "I didn't know Hacker was a writer, too."

Scott nodded vigorously. "Charles Augustine Hacker, noted author and scholar—they told me *all* about him. Say, did you know he's had five books on the New York *Times* best-sellers list? The titles were things like, let me see. *The Coming of Crisis, Decade of Decline*, and, uh, *Into the Abyss*—"

"That's it!" Bob slapped the sheaf of papers into his open palm, and laughed.

"What's what?"

"Never mind—it's sort of embarrassing." He was grinning with relief. "Right now, I'm going to dig up the other department heads and sell your scheme to them."

It was early morning, by the clock, when Bob returned to the clinic. He

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hadn't been too surprised at how readily everyone accepted Scott's idea to speed up the mining project, even at the cost of delaying a dozen other valuable and beloved projects. The idea of striking a blow against the Russian and South African dictatorships had an almost hypnotic appeal. He'd spent more time in juggling the shipping schedules and budgetary allocations, whipping the new quarterly budget into shape, than he had spent in expounding the plan. Bob had put Hacker and all he meant from his mind, but now he knew it was time to share his insights with Helen.

He gasped in surprise when he saw her. Helen sat at her computer console, with bags under bloodshot eyes. "'lo, Bob," she said listlessly.

"Are you feeling all right?"

"A little woozy, is all." She waved a hand at the console's screen. "I had a lot of researching to do, so I gave myself a shot of synaptrine. Been working on the Hacker stuff all night."

Bob wanted to kick himself. Synaptrine was a mental stimulant which altered the passage of subjective time, allowing the user to perform extra mental work in a limited period. Helen had bought herself several extra days, Bob saw, but the price looked steep.

"Hacker was wrong," Bob said. "I'm sorry, I should have told you sooner. I figured it out when I was talking to Scott."

"Hm? Oh, of course Hacker's wrong. I realized that myself pretty early on. Tell me what tipped you off. Knowing you, it was intuitive."

"It just dawned on me that he didn't have a certain intellectual honesty. Scott told me that he had written some books—"

"I just read them," Helen said, tapping the console screen. "They're basically popular versions of articles he's written for psychological journals."

"So you know what they're like, even better than I know," Bob said. "The titles sum up the contents, don't they? Essentially, Hacker thinks that modern society is going to hell, right?"

"Yes, he does." She stifled a yawn. "His books are full of it . . . in more ways than one. Man can't take the stresses generated by modern society, he says. Technology has destabilized the foundations of life. Scientific creations form dangers to life and limb which are beyond human comprehension. The world is horribly complex and nerve-wracking—as if the Dark Ages were a picnic! It's an old, dumb line," she concluded.

"But I assumed he was honest," Bob said. "Unpleasant and disagreeable, perhaps, but honest enough to have an open mind. It didn't occur to me that anyone who calls himself a scientist would already have his mind made up about everything. He didn't investigate us; he just filtered us through his prejudices."

Helen nodded. "If he didn't do that, he wouldn't have the material for his next best-seller."

"And he'd have to admit that his judgement was wrong," Bob said. "Which is a hard thing for anyone to do. But that still didn't convince me he was wrong. His motives may have been less than pure, but that alone wouldn't invalidate his ideas. It was his attitude of hopelessness that gave me the an-

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swer—he seems very energetic, but in his heart he's despondent. When he thought that the colony was in trouble, he decided that the only solution was for us to run away, to go back to Earth. You and I assumed from the start that there had to be a better answer and that we could find it.

"Our perceptions of one another were all wrong," Bob continued. "We assumed that he came here to make a legitimate, objective study of the colony, so we automatically took him seriously. For his part, he took it for granted that we'd be worried sick over infinitely small chances of being killed by the lunar environment, because to him that's the normal outlook. It was like sticking a direct-current voltmeter into a wall socket. It'll give you a reading of zero volts, but only because a DC voltmeter isn't designed to register alternating current. There could still be a lot of power there."

"So he was reading us wrong, misdiagnosing the symptoms," the doctor said. "He couldn't see the use of jargon as just plain humorous. And what he called 'marriage customs' . . . the old boy had to look wrongly at them, too. You compare psych profiles when you get engaged because it can keep you from hurting someone you love, as well as yourself. Going into a marriage that's bound to fail is a lousy way to show love—but Hacker couldn't see it that way."

"Right again." Bob pulled out the room's extra chair and sat down. It was a bare metal chair, made comfortable by the lunar gravity. "Y'know, Scott's idea caught on pretty fast with the other department heads. What do you suppose Hacker would think, if he knew that the only thing any of us will get from the deal is the simple satisfaction of causing trouble for a couple of police states?"

"I know what he'd think. When I got back here yesterday he was still here, trying to access my files. We had a pretty wide-ranging argument. Before I kicked him out, I told him about it." She looked wry. "He thought the idea that we could benefit Earth was a silly, touching little conceit, and our motive was just to put ourselves in a better position. And what are you smiling about?"

"Several things, I guess. It's a relief to know that we're out of the woods with this thing—and it's embarrassing to know we were never lost in them to begin with."

Helen's laugh was mirthless. "Guess again, buddy. I didn't squirt myself full of synaptrine until *after* I realized that Hacker was talking nonsense about us. I'm afraid we've got a pair of real problems on our hands."

Bob felt the crawling sensation again. "But I thought—"

She held up a hand, and Bob saw that it was shaking slightly. "The trouble isn't on the Moon. Listen. Once you decided that the settlement was in no danger, you stopped worrying about Hacker, didn't you? That's the way your mind works—you feel responsible for the colony, my leader, so you're sensitive to its needs and safety. Trouble is, you don't always extend that sort of attention to the rest of the universe.

"Take a close look at Hacker." Helen paused to massage her temples. "D'you recall that he said you could 'fix' a bad marriage with a divorce? Just chuck it out. He gets 'free' with 'rec-

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reational pharmaceuticals'—there's a telling bit of jargon for you, Bob. One way or the other he always runs away from his problems. His books are loaded with things along those lines."

"So he's a loser," Bob said. "What of it?"

"He's a very significant, very influential loser," Helen said. "He writes popular, best-selling books on psychology. His professional articles are well regarded by his fellow psychologists. He tells people that they and their civilization are disintegrating—and they snap it up. People don't listen to him and applaud him because they want to be convinced that their world is falling apart. They listen to him because he can state very articulately what they believe implicitly. He's popular because he caters to beliefs which are very, very widespread down there. Think of him as a symptom, or a sensor readout."

"You mean that he reflects society's mental orientation?" Bob suggested.

"Yes, that's it. He reflects *his* society's attitudes, not ours. F'rinstance, we've had eight or nine major flares while we've been up here. Everybody took them in stride, because we're deep enough underground to be perfectly shielded. We know the physics of the situation, you see, and we believe it's right. Down on Earth, though, most people seem to think that radiation physics is black magic. Remember what happened after the Los Angeles quake of '88?"

Bob scratched his head. "Wait . . . yeah. There was some screwy rumor that the San Onofre reactors had melted down, wasn't there? There was a big panic."

"There was," Helen agreed. "And it killed more people than the quake. Folks were primed to believe that reactors were dangerous and just waiting to melt down. A few rumors set off the hysteria. Few people even stopped to realize that Los Angeles was upwind of the reactor site, so there was no danger.

"Now, just how important this is depends on how seriously you take history. Back when I was in high school I learned about one incident that I never could forget, but that never struck me as being important—until now.

"It happened in Constantinople, in A.D. 398. The old Roman Empire had split in two by then, and Constantinople was capital of the eastern half—what was left of it. One day there were some earthquakes, and an abnormally high tide. That set people's nerves on edge. Then a government official said that he'd had a vision that the city was about to be destroyed. That served as a spark. People got alarmed, then hysterical. Some of them thought they smelled brimstone, and others claimed they saw an enormous red cloud rolling towards the city. Dire sermons were preached. Rumors ran wild. After a week things culminated in a mass exodus from the city." She smiled wryly. "The Emperor Arcadius was the first man out, and the city was left abandoned for most of a day.

"My teacher said that this event was more significant than the barbarian sack of Rome a decade later. It was her choice for a dividing line between the optimistic, dynamic world of ancient Greece and Rome, and the forlorn pessimism of Europe in the Dark Ages."

Bob gave a low whistle. "I see your

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point. History never repeats itself—it just hits you over the head if you can't learn from it." He let out a long sigh. "If Earthside civilization is going down the tubes, we've got our work cut out for us. I don't know just what can happen when a complicated, nuclear-armed civilization heads into its own Dark Age . . . but we'll have to take steps to keep from getting dragged down with it. That means making the settlement self-sufficient as fast as we can. That still could take years." His voice was grim but determined. "I'm not ready for another Dark Age, even if someone like Hacker—" He cut himself off, then swallowed. "Hacker. Damn."

"Hacker," Helen said. "He's the other problem I mentioned. The collapse of Earthside civilization is a long-range problem. Maybe it's inevitable. Maybe it isn't. Maybe we colonists can prevent it, or alleviate it, or at least survive to help pick up the pieces—but if we don't do something about Hacker we won't last long enough to need to worry about that."

Bob nodded glumly, and wondered how he could have forgotten about Hacker's importance. Helen had just shown him how influential the man was. No wonder NASA had allowed him free passage to the colony, and ordered Bob to treat him with kid gloves.

"The things he told me," Bob said. "His 'observations'—they're going to be the theme of his next book, aren't they?"

"Undoubtedly." She jerked a thumb at the console. "He'll do again what he's done before. I've been investigating him. He'll write another book, make the lecture circuits, appear on the tube and in the papers, speak at rallies—"

"—and various politicians will jump on his wagon," Bob concluded. "I know how this game is played. They'll promise his followers that they'll cut off all the money that's being thrown away on a doomed project."

"Anything for a vote," Helen said.

"We can't let that happen! This place—damnit, how can any intelligent man fail to see how important we are to humanity's future?"

"By being devoted to enhancing his own power and prestige," Helen answered. "Bob, I sincerely tried to convince him that he shouldn't do a number on us. I've never been so eloquent in my life—and it didn't work. I couldn't turn him around any more than I could push the Moon out of its orbit."

Bob began to feel a helpless, sinking sensation. He realized that it wasn't brought on simply by the threat Hacker represented to the settlement. If Hacker managed to cripple the settlement—what then? Without the mining project alone, there might be a world war over diminishing resources. The damage that Hacker could do didn't bear thinking about.

" . . . stop him," Helen was saying. "We can't let him make us the target of his jeremiads. We've got to pull his plug—discredit him."

"How?" Bob asked.

"I've given this a lot of thought," Helen said, without irony. "It's the real reason that I took that synaptrine. What I have in mind is cruel and brutal, but I can't see any other answer.

"Mentally, he's on the brink. Maybe it's psychosomatic, or maybe he isn't equipped to live in a place like this—I couldn't say. But I can push him into

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a nervous breakdown. He'll need months to recover, and he won't cause any trouble while he's out of action. When he does recover, he won't have much power or prestige left. There's a big stigma attached to mental illness. People don't put their trust in leaders whom they regard as crazy."

"There must be some other—"

"There isn't," Helen said sharply. "We can't reason with him, I've tried. We can't out-argue him on Earth; we'll be up here, he'll be down there, and any arguments we could make won't have half the emotional impact his will. Forget about murder; even a genuine accidental death would look suspicious if it happened here. And we can't kidnap him and hold him incommunicado for the next few decades.

"Now," she pressed on, "we'll have to get his two assistants out of the way. They might figure out what's going on. Luckily, Hacker said he wanted to send them out to inspect some of the outpost stations, so let's let them do that. Put them on a rolligon and get them out of here for a few days. While they're gone I'll subject Hacker to some reverse psychotherapy, under drugs and hypnosis. There won't be any evidence of foul play—he won't even be able to remember what we did to him. Not even an expert psychologist will be able to find out about this by examining him."

"But we'll know," Bob said.

"Yes. But I'll be the only one doing anything unethical. You can leave it all to me."

"No, that isn't it. . . ." The idea of destroying Hacker appalled Bob. Yet the only alternative was worse. Hacker planned to take a sledge-hammer to humanity's future—and if he did nothing to stop him, Bob saw, that would be tantamount to admitting that his faith in the colony's importance was a delusion, that it wasn't worth defending. There was no third course; he couldn't throw up his hands in moral indignation, and let things go to hell because he was too self-righteous to make a hard choice.

"I can't just leave it to you, Helen," he said firmly. "Let's get it done. I'll get Hacker's aides out of here right away, and I'll make sure you aren't interrupted when you do it to him."

"Good. I'll have to do it here. I can use my files to bait him, before I nail him." She eyed him critically. "I won't lose my nerve. How about you?"

"If we have to destroy him to save this settlement, I can do it. I will. Just understand that whatever authority there is to do this is mine—and so is the ultimate responsibility." Perhaps there was no real choice open to him, Bob told himself . . . but it would be a long time before he slept soundly again. ■

● There are cities and companies, unions and political parties in this country that are like dinosaurs waiting for the weather to change. The weather is not going to change. The very ground is shifting beneath us.

John Naisbitt, *Megatrends*

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EXPIRATION POLICY

Laurence M. Janifer

An intelligent species spread among the stars is likely to evolve quite a range of social systems—each with its own vulnerabilities.

Richard Crist

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A bureaucracy is (by definition) a mistake. The definition is mine, and it arises out of long and painful experience.

My business card says *Gerald Knave: Survivor*. It's an interesting career, and every so often it means that the Comity finds out where I am, and asks me to go out to some uncolonized pill or other and live there for a while. I usually do, and when I come back I have a report filled with things like the peculiar biting saurians of Rasmussen, or the poisonous midges of Ferris, or maybe just a lot of volcanic action, combined with earthquakes, lightning, hurricanes, and other bothersome catastrophes.

Since I do come back, my report is also filled with ways to get round these difficulties. Many people, and the usual small boggle of computers, get together at this point—sometimes, unluckily, with me, if I have not had the good sense to leave for almost anywhere else—and study what they have called my Recommendations. After a while, they all get tired of doing this, and one way or another a colony is sent out. The colonists are issued one-way, one-time-only space-four cards, they get several speeches and a mixed bag of supplies, and usually—not always—the human race grabs hold on another planet.

The bureaucracy keeps talking about dangerous planets, dangerous animals, dangerous climates, and all that sort of thing; this is their mistake, and it is not possible to cure a bureaucracy of making it. I know: I've tried.

There are no dangerous planets.

Some are uninhabitable—by humans, anyhow. Except for the Astronomical Dome, anybody who wants Pluto can have it, and Jupiter is waiting for a race with strange enough tastes to happen along—just to keep things in the Solar System, where the Comity bureaucrats are.

The inhabitable planets are survivable. There are no dangerous animals, or climates, or—well, you get the idea.

There is only one dangerous thing in the Galaxy, so far. Its name is Intelligent Life, and except for actual war or absolute threat thereof, Intelligent Life tends to define as Man. If you happen to be FemLib, you can add Woman; the rest of us are content with standard grammar.

So, every once in a while, I like to do my own checking. I go out and try surviving on a world that offers some *real* threats—a world that has human beings on it.

Human beings can kill you, very suddenly, and many of them do. They can even—well, take a look at Alphacent, for instance. That's the world that has the Ancestors.

Capital A. Alphacent was one of the first extraSolar worlds, and by now it's developed its own traditions. And the biggest, most visible tradition around is this business of Ancestors.

On Alphacent the Ancestors run things. All it takes to be a power in the land is dying. Once you are dead and nicely planted (the Cents have cemeteries the way other people have luxury resorts), your word is law. Naturally, there is a small group of specialists in every town on the planet, who listen to the Ancestors and pass this word along; it would be a little too much to expect the Ancestors to do all the work themselves.

The trouble is that the specialists are

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perfectly honest. There seems to be a sort of nut strain in the Alphacent gene pool, and these half-psi people pop up all over the place. They have visions, they go into trances, they spend a lot of time staring at walls, and a few of the most highly respected ones have developed quite a line in drooling and swaying. The experts say it isn't epileptoid, though to an unprejudiced eye it certainly looks it; a specialist can drop into his trance any old time and spend hours lying in the road, surrounded by worshipful locals, until he snaps out of it, blinks a few times, and recites the latest commandments from Beyond.

The system seems to work about as well as any form of government ever works. I have no idea what that means, and I refuse to speculate on it. To tell the truth, I prefer bureaucracy.

A little, anyhow.

That trip, I hit Alphacent with nothing more on my mind than taking a better look at those specialists. Maybe there was some sort of authentic psi talent to be dug out of the goops. Maybe the times had produced the men, so to speak, and the thing was a disease, and curable—that was an interesting notion, because if I could prove it I would be in an extraordinarily doubtful spot. The whole damned planet actually runs on this disease. Do you cure it?

And maybe there really are Ancestors, directing the show from that great home of omniscience and second thoughts, the Beyond.

What the hell, it's possible. And a survivor (by definition again) is an information collector. What keeps me alive is knowing the right fact—but I have no idea what it is until I need it. So I collect as much information as I can, and hope that some of it will be handy for the next tight spot I get myself into.

Alphacent has a spaceport, but it's manned by starship troops—the level of technology is too high for the world to support on its own. I exchanged military-type greetings, found a car—an honest wheeled jobbie, no ground-effects cushion and no helpful little brain in case of sudden stops—and headed out toward a town I remembered, about sixty kilometers outside the posted spaceport land.

The place had been called Thrush, and it had been a well-to-do sort of place, for Alphacent. Some of the mud huts had actual plastiglass windows, for instance (offworld traders do show up; the world has some interesting mineral deposits). The leader of the living—a sort of sub-mayor—had been a tall, proud man named Alfroid; I remembered him with some affection, since he could tie loose knots in iron bars, and had drunk me under the table one evening—no, an evening and a morning and part of an afternoon.

I came to Thrush, and even the outskirts looked different. The huts were tumbling down; the people I saw, and I didn't see many, were wearing flat-out rags and looked like refugees from a seminar on Starvation; the whole town, in the middle of a bright, hot, sunny afternoon, looked as if it carried its own cloud around with it, all the time.

Something had gone very wrong. Four years Alphacent—about three and a half Standard—just isn't that long a time. I drove on through to the official

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building—where Alfroid had lived—and stopped in front of it.

I remembered it had had four fine plastiglass windows and a metal door. But the window-spaces were boarded up, and the door was a flapping curtain.

I climbed out of the car and Emsy came running from the house waving her arms and sounding glad to see me. Emsy was Alfroid's wife and spare mayor, a girl about as big as your average ten-year-old, with round wide eyes and ringlets of gold hair. Altogether a decoration in the landscape.

"The strong man!" she was shouting. "The strong man has come back!"

I took that kindly, remembering Alfroid—but nobody counted Alfroid as a strong man, he was just a local, he lived there. I went the ten yards or so necessary to meet a running Emsy, and she hit me like a tackler, threw her arms around me and went on making happy sounds.

"Where's Alfroid?" I said after a bit.

She turned to stone. "He is inside," she said. Her eyes wouldn't look at me. "He has not been respected."

In other words, he had opposed some decree of the Ancestors, and been hit over the head with the town. The town looked as if it had hit something, I will say that—something about the size and shape of a plague.

"Let's go see him," I said, and disengaged myself, took her arm and started back across the dirt street to the house. "Maybe we can think of something to cheer him up."

Emsy dragged her feet. "How can he be cheered?" she said. "The Ancestors have spoken."

"Well . . ." Suggesting that the Ancestors might have been wrong was not the correct move. I'd had a lot of fun in Thrush, and as it happened, I'd been fairly popular here and there; but that suggestion would make me as welcome as an import of Ferris's poisonous midges, even with Emsy. Even with Alfroid—my bet was that he'd gone no further than to suggest a second consultation, just in case the Ancestors had been misunderstood.

He was lying on a pallet in an inside room. Kids were running in and out—they'd had four, I think, the last time I'd hit the world, and there seemed to be several more this time around—and making fairly happy noises, but Alfroid was immune. He lay like a statue, seven feet tall and beginning to waste away, his eyes deep in his head and his face set in an expression that looked like the original for every mask of tragedy I had ever seen.

"I heard the sounds," he said. His voice was a big resonating sound, something to shatter trees with. Or it had been; it was dying away. "I am glad to see Knave with us again. But he will not remain long."

Emsy said: "Perhaps he will. Perhaps he will help—"

"There is no help," Alfroid said flatly. "The Ancestors have spoken. There is nothing more to do; we are at an end."

I looked around, and found a three-legged stool. I balanced myself on it, and Emsy went out and came back with local beer in two large clay mugs, and I said: "Tell me about it."

Alfroid looked at his mug. I took a good pull at mine, to give him a little inspiration, but he picked it up and

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looked at it and sighed and put it down on the floor next to his hand. "You do not know of the Chief Speakers," he said.

I ran down the list of occupations and titles I remembered from four years ago. "No," I said. "Never heard of them; what are they?"

"They know the Ancestors," Alfroid said. "They are Speakers for all Ancestors, everywhere."

I took another pull at the mug. Emsy was sitting crosslegged on the floor with a mug of her own, sipping away and holding the thing with both hands; she was one of the few human beings I've ever known who could pass for an elf. "Where did these Chief Speakers come from?" I said. "Every village has its own Ancestors."

"So it has always been, and all has been well," Alfroid said. The talk seemed to be reviving him a little; he actually took in some beer. I saw Emsy smile. "But the Chief Speakers have come, and they speak for all villages. They speak for Thrush, and Thrush will be no more."

"Now, wait a minute—" I began.

"I tell you, it is a proven thing," Alfroid said. "It is only one year since our own Speakers told us of this; and if you have come through the village you have seen the change. We are at an end."

I'd been wondering about an extremely simple and nasty scheme, involving offworlders who came down and just claimed to speak for the local Ancestors, grabbing everything of value in Thrush because the Ancestors had so commanded.

But Alfroid wasn't stupid. Neither were most Cents. A stranger making that claim would have to back it up—with detailed knowledge of the Ancestors, for one thing.

And, as Alfroid had just reminded me, with the agreement of the local speakers—the half-psi goops Thrush used as regular mouthpieces for the tables of the law.

So I asked some more questions, declined Emsy's offer of dinner—there wasn't enough to feed two adults and the passing crowd of children, and Thrush might still have an inn—and retired, looking as cheerful as possible and not fooling Alfroid at all, to think things out.

The situation, clearly, was a little more complex than I'd thought.

Well, they usually are. And—down to one cook and one servant—there was an inn. Much food, and little beer, to keep my head clear, and a cozy bed under the mud roof.

It rained that night. The roof didn't leak much.

Running over what Alfroid had told me, pieced out by deduction where necessary, I came out with something like this:

The Chief Speakers—offworlders for sure, since they had a different skin-color (which is damned rare in the Comity worlds these days, or the Frontier worlds either) and wore clothing that shone, which I took to be spun silk or something of the sort—hadn't begun with Thrush. They'd started with another town, nearer the spaceport.

And their story had been very simple. They were in constant touch with all the Ancestors of Alphacent. They had been

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living on Alphacent's single moon for years and years, listening to the Ancestors and learning to communicate with them full-time, without the usual fits and starts.

They were primed with wagonloads of casual detail. Murk's father, who had died two years before, had had a blue birthmark on his lower leg. The mother of Durba, dead six years, had always been ill after eating the local chicken (allergy, maybe; but Alphacent didn't have the concept yet). The uncle of one of the local speakers, dead ten years, had never thought the girl would come to any good, and was most surprised to discover (after his death) her high status.

And so on, and so on. Little details —and they all checked out.

Then, one by one, the local speakers—that town had three—went into trances and confirmed the high status of the newcomers. They were indeed Chief Speakers, and they were to be obeyed. In everything.

Their edict was simple and brutal. Sell your house, sell your goods, dig up your money—bury it all in the center of the graveyard. In five years a tree bearing ten times as much would bloom there. Meanwhile, things might be tight, but when the five years were up every Cent would have more than he could ever need; the tree would never stop blooming.

Alfroid hadn't been the only Cent to object—nor the first one.

He had been, I think, the first one not to be lynched.

Damn it, this was the proven word of the Ancestors.

Town after town—Hamback, and then Thrush a year ago, and by now halfway across the planet. It would not be hard tracking them down—but what did I do then?

Killing them recommended itself to me. There were only three of them, and it seemed a contribution to world sanitation. But first of all, doing it without getting lynched myself looked like an interesting trick; and second, once they were dead they were Ancestors themselves, and their last commands would be even more thoroughly obeyed.

In five years, people would find out that the trees weren't going to bloom. But by then there might not be any Cents left to care; those Chief Speakers had been thorough.

After some thought, it struck me that I needed one fact. I had to know when these Chief Speakers had landed on Alphacent. I rather thought it would be about five days before they had turned up at the first town.

I went back to the spaceport next morning, driving that monster of a car as if I were convinced it wouldn't up and kill me, and had a talk with the staff. They couldn't interfere with the Cents, and didn't much want to; they were on two-year tours of dull duty, and had no particular interest in the locals. If the Cents all died out, maybe the port would be closed down and they could go on to something more interesting; it's called the professional attitude. You can't quarrel with it much, people being built that way. Sometimes you can regret it.

"About five days": the actual figure was six. And Emsy answered one more question for me: had the Chief Speakers gone directly from town to town?

Well, not exactly. They'd left Ham-

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back four days before they arrived at Thrush; and Emsy happened to know —she had relatives in Whetstone, the next stop—that they'd left Thrush five days before arriving in Whetstone. The traveling distance, on foot, was maybe four hours.

Late one night, therefore, I abducted a goop—pardon me, a Speaker—and robbed a graveyard.

After that, all I had to figure out was how to play the hand.

Halfway around the planet was just about right. I tracked them from town to town—the hell with that car, I borrowed a heli from the spaceport and set down in empty fields where I could, big crossroads where I couldn't—and spent the better part of two weeks on the job.

I walked into Jeritree at noon, just in time to hear the tail end of the standard speech.

I wasn't noticeable—not to offworlders. I'd borrowed some local clothing from Alfroid before I set out, and had Emsy put a tuck in it here and there, since I am not seven feet tall, among other things; and I had a fine stupid expression on my face that must have reassured the three Chief Speakers.

Anybody from Jeritree would have caught me as a stranger at once—on Alphacent, all the towns are small towns, and everybody knows everybody, within reason—but they weren't interested in me. The Chief Speakers had all the attention.

"You have heard our proofs," one was saying—the tallest one, about my size, with near-white hair and a stern expression. The clothing was silk, all right—with metallic glitter woven into it. It seemed pretty flashy for every day.

He went on:

"You have heard your own speakers. They tell you that we speak for the Ancestors of Jeritree. You have heard our talk of those Ancestors; you know we speak truly. And our command comes from them—it brings no profit to us; we are but messengers, who must obey their will."

So far, it was about as expected. But there was a new touch.

"In Thrush, a town far away—perhaps you have heard of it—?"

There was a little murmur. Everybody knows everybody—within the local radius of travel. Thrush would be a sort of distant legend, brought vaguely up to date every few years.

"In Thrush, the tree has already bloomed!" the big one said. "You may ask your own Speakers—there, the good life has begun for everyone! Yes, in Thrush—"

I turned off my ears. I didn't have to take any more. I only had to look passably native, and wait out the speech.

And I thought about Thrush, where the good life had begun for everyone —where starvation was creeping in, and Alfroid was dying of pure uselessness.

When the speech finally ended I faded off down a side street, and kept moving. I spent the day avoiding people and looking inconspicuous, which was fairly simple: the Chief Speakers were the only topic, and unless I had sprouted six green ears out of the center of my forehead nobody was going to get interested in me. I wasn't a Speaker, I wasn't an Ancestor, so it didn't matter what the hell I was.

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Fine with me. Evening came at last, and with it the ritual burial of precious metals, hoards of valuables, titles to land—a whole town's worth of value, sunk in one very large hole in the dead center of the Jeritree cemetery. The town trooped out for it, and I made one in the procession.

Then the town trooped back, and I followed along until we came to a bend in the road and a slight rise.

I went behind the rise, found a ditch, and disappeared.

Nobody had noticed me come; nobody noticed me go.

Everybody was being very solemn.

I heard them go by. Night noises started up; every planet has its own orchestra, usually eight or nine different flavors depending on the particular continent, climate or season. Alphacent included one beast—a sort of insect with an inflatable thorax and a hell of a resonator—that sounded exactly like a strangling cat. I passed the time trying not to listen to it.

Full dark came. The Alphacent moon gives about twenty percent of the light Earth's moon provides; Alphacent dark is a canful of gloom at the bottom of a rainbarrel.

My eyes were used to it by then. I found my way back with no trouble at all.

To my surprise, only two of the Chief Speakers were at the big hole, doing the digging.

I like slug guns: they're big and noisy and what they hit they stop. But there are occasions for silence, and that was one: I marked a spot in my head, about two feet from the mound, and hit it with a beamer.

The dirt gave off a slight sizzle, and the beam was a very visible pencil of light. One of the duo—the tall man—said: "What the hell?" in Comity Standard, not Alphacent, and with an Earth accent—and all motion stopped.

I came round to face them, holding a beamer in either hand. I was just visible, no more; it was enough. I said: "It's all over."

And the spare third guy jumped me from behind. Well, he had to be somewhere.

Maybe he'd been resting, maybe he was covering the dig just in case. He made the hell of a good jump.

If I hadn't moved, he'd have had me. But he'd been audible back there, since my single beam. I stepped aside and he went straight on, arms outstretched, and landed with his nose in the half-dug hole.

"What the—what do you mean, all over?" the tall man said, after the crash. "Who the hell are you? We're just—"

"I've been tracking you from Thrush," I said. "I'm not a Cent. And you're not a Chief Speaker—we're even."

"Comity law?" he said. "This is an independent world—works on its own laws. Comity law can't touch us here."

He was right. If I'd been the law—local or otherwise—the point might have bothered me. On the other hand, it might not; I could hardly imagine a human being who'd let a little thing like the legal code stand in his way when dealing with these particular specimens.

But I wasn't the law. I was only just me—surviving.

And helping Alphacent to survive, too.

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* * *

Wrapped and tied, the Speakers went back over the planet, town by town, explaining that the Ancestors had a new word for everybody, and arranging for the return of goods.

I have never spent a more boring three weeks—but it was worth it to see the expression on Alfroid's face when we got back to Thrush, and the money and the valuables and the land titles came back. Along with the new word from the Ancestors: "We have tested you, to see your obedience. We know now that it is great. Take back your goods—use them well, and prosper."

I left the Speakers their ship. They had not arrived on Alphacent totally broke; but, except for the ship, they left that way—and were damned glad to do it.

And they had not really tried anything very complex. It looked that way—but the answer was in that five-or-so days' gap.

Suppose you arrive just outside a town—secretly, by night, with all your glitter packed away. And you abstract the Speakers, maybe only one a night.

And you do what can very easily be done to almost any psi, or half-psi, or epileptoid . . .

Right. You hypnotize him.

You fish out a lot of local Ancestor details, you give him a posthypnotic that assures you of his cooperation—he's going to believe that the Ancestors spoke to him and gave you the okay—and you hand him a forgetter covering the actual hypnosis.

You have to work slowly: just getting the detail takes time, and you can't kidnap Speakers carelessly; it has to be worked in secret.

So you spend five days—or four, or six, whatever it takes. And then, fully equipped, with confirmation assured from the local Speakers, you march on in, at Full Glitter, and start your act.

Simplest thing in the world, damn it.

I didn't tell anybody, not even Alfroid or Emsy. You don't tamper with belief unless you have to; it has a very short fuse, and it may blow up the believer. Which is why I invented the face-saver for a story, and let the Speakers get off the planet.

They hadn't really studied up on Alphacent law, you see.

A crime that might be punishable by death somewhere else is punishable differently on Alphacent; after all, they don't want to send criminals up among the Ancestors until they've had time to repent very thoroughly and be good Ancestors themselves. So they have something a good deal worse than death—so much worse than my pet Speakers were gloriously happy to get off the planet with their bare ship.

A major criminal is kept most carefully alive—in constant pain.

The process—it involves an Alphacent insect, though not the one that sounds like a strangled cat—is a little like being staked out on an anthill full of very dedicated army ants—and being very carefully fed and kept alive—for between five and ten years.

At the end of that time, the criminal is repentant. He says so. He says a great deal—he isn't remotely sane any more.

The Alphacents don't kill people. They're much more dangerous than poi-

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"MIND-CROGGLING"... Harlan Ellison

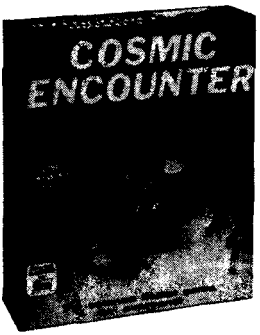
Best SF Game
Games Day, London 1982

Best SF Game
Space Gamer Mag 1980, 1981

2nd Best Family Game
Games Day, London 1981

Ten Best Games Hon. Men.
Omni Mag 1980

Games 100 Best Games
Games Mag. 1980, 1981, 1982, 1983



"Cosmic Encounter is a teeth-gritting mind-croggling exercise in What-If"... ***Harlan Ellison***

"So much fun you forget how strategic a game it really is"...Games Mag.
"SF Involvement...fast (paced) and tense..." **Isaac Asimov's** Mag.

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son, or volcanoes—they're human beings.

Of course, I'm not a Cent, and I have a simple, direct mind.

So, while I was going through their ship for valuables and taking what I found—well, it covered expenses, so to speak, and bought some baubles for Alfroid and Emsy's kids—I planted a bomb in the drive.

I cut the Speakers loose at the last minute, and got out under the protection of the spaceport guard—Comity law, on Comity territory.

If I calculated it right, and I should think I did, the Speakers became loose atoms and a little energy three days out, quite out of range, and not very noticeably. Just another accident; and there are always accidents.

I don't regret it. They were men who could make a simple scheme work like a Swiss watch. And, my God, where would they have gone next? And—what weak spot would they have hit?

Because every culture has one. Ancestors . . . bureaucrats. . .

Something—just waiting to be used as a target, by the only dangerous being around. ■

● If right-handedness is determined by development of the left side of the brain, is it possible that only left-handed people are in their right mind?

Kelvin Throop III

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On Gaming

Dana Lombardy

Of nearly thirty new role-playing games (RPG) introduced in 1982, five reached the final ballot in the H.G. Wells Awards category for "Best New Role-playing Rules."

One is already out of print and will not be published again in the same format. The other four titles show how diversified role-playing has become. RPG no longer involve just fantasy or SF; their "universe" now includes other areas, as well.

Behind Enemy Lines by FASA Corp. (Box 6930, Chicago, IL 60680) enables you to become a U.S. soldier in WWII. As part of a small squad of soldiers, you're a paratrooper, a ranger, or a basic infantryman. Unlike in fantasy adventures, your team is not after treasure. Instead you work together to accomplish a specific mission through patrols, ambushes, or skirmishes with the enemy.

As with other RPG, you need a referee to set up the missions and direct the flow of play. The referee also keeps track of weather, the enemy, and other non-player characters. Unlike other RPG, this game allows each player only five character attributes: strength, endurance, weapons handling, agility, and stamina.

Behind Enemy Lines comes with a 96-page book of basic rules, a 48-page book of event tables (random encounters, etc.), and a 56-page book with three full-length missions, four incidents, and 192 non-player characters.

There's also a 16-page folder with maps for the missions in the game, 112 illustrated counters representing American and German soldiers and equipment, two dice, and four sheets of tables used most during the game.

Recon by RPG, Inc. (Box 485, Lincoln, AR 72744) is also a military RPG, but uses a more modern setting. *Recon* is a 44-page book of rules subtitled "The Role-Playing Game of the Viet Nam War," and is based on the small reconnaissance units used during that war such as the Navy SEALs, Marine Long Range Patrols, Special Forces A Team, etc.

Since its introduction, *Recon* has become the basis for gaming other modern military operations, including real and hypothetical coups and terrorist activities. All of this puts *Recon* in a controversial position.

To some degree, *Behind Enemy Lines* shares this problem. Both *BEL* and *Recon* deal with real situations—not a make-believe past of magic and monsters or a speculative future of space travel and aliens.

There are just as many violent, treacherous, and other potentially negative situations in SF and fantasy RPG. But for some people *Recon* may be a little too close to reality.

Daredevils by Fantasy Games Unlimited Inc. (Box 182, Roslyn, NY 11576) time-warps you back into the exciting pulp adventure stories of the Thirties. If you're familiar with Doc Savage or with the movie *Raiders of the Lost Ark*, you'll understand the premise.

The rules are artful, with lots of jar-

(continued on page 89)

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The Alternate View

GARBAGE IN, CONFUSION OUT

G. Harry Stine

The ubiquitous nature of the modern high-speed general-purpose digital computer has led many people to utilize such a machine to legitimize what would otherwise be empirical guesswork. I refer specifically to the emerging "science" of economics.

The word "science" is deliberately placed between quotation marks because economics doesn't yet qualify as a true science by most of the criteria used to justify an intellectual endeavor as being scientific. Not only is a science an organized body of facts which must explain existing conditions or provide a rationale for observed phenomena, but it must also be able to *predict* with a high degree of accuracy and probability future occurrences falling within its sphere of intellectual activity. The late Harry L. Swartzberg of RCA formulated an excellent test of anything somebody wants to label as a science: "The validity of a science is its ability to predict."

Astronomy, which is perhaps the mother of all sciences, is very good at this sort of thing. You can be certain with nine-nines probability that the sun will rise tomorrow when the almanac says it will, provided the balloon doesn't go up (as our British colleagues might put it). Eclipses and occultations can be predicted with surprising accuracy.

The physical sciences used in engineering work also qualify under the Swartzberg Test. If the bridge falls down, it means that some engineer made a mistake or a quality control inspector goofed or a mechanic screwed up. It didn't happen because the universe was capricious, but because some human being didn't fully understand it, made a mistake, or simply got sloppy. One thing we know for certain: getting sloppy when dealing with the real world greatly increases one's chances for permanently departing said real world.

The emergence of the large general-purpose digital computer provided enormous assistance to astronomers, engineers, and others who had to fiddle with gobs of finicky figures for days, weeks, or months. The number-crunching capabilities of even the small personal minicomputer make this sort of work a lot easier.

But the charisma of the computer has led many scientists to use it to crunch large quantities of numbers looking for any correlations that might exist which they can't readily determine. Thus, "wall to wall data" is fed in and the results are thereafter usually accepted as gospel because the computer produced them.

The capabilities of the computer to be programmed to handle wall-to-wall data in interesting and innovative ways has also allowed the development of new mathematical models of the physical universe. A model is an analog, and

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there is no perfect analogy between a model and the real world. But it can come close. It depends upon how tightly one has a grip on all the variables in a system. Like any mathematical analysis, a computer model will only tell you the logical consequences of your initial assumptions. You can easily slant the results by carefully writing the program and/or selecting the data. Basically, GIGO (Garbage In, Garbage Out). Now and forever. A good example of this is the Jay Forester "World Dynamics" model used by Dennis Meadows and his colleagues to come up with their infamous "limits to growth" philosophy. I'm not saying that they deliberately distorted or selected their data, but they certainly did neglect to include some. And they made a number of blind single-element extrapolations of the same sort that many science-fiction writers use when they are cranking out a story of the "if this goes on" sort. And they didn't consider the most obvious social consequence: a world of limits means a world of totalitarian control over and physical coercion of individuals. That's not the sort of a world I want to hand over to my children and grandchildren.

Economics is defined in the dictionary as the science that deals with the production, distribution, and consumption of commodities. But it isn't a predictive science, and it won't pass the Swartzberg Test. Yet.

Over the anguished screams of my economist readers, let me point out that if economics were indeed a predictive science, the world would be in much different shape than it is today. The Soviet Union's planned economy would have been enormously successful. And the United States would not have just gone through the worst economic recession (to some a depression) since the one that clobbered the world during the period 1929–1934.

A recent issue of *U.S. News & World Report* magazine included lengthy statements by six different economists, none of whom could agree with the others. It's neither unusual nor necessarily disruptive to have scientists disagree with one another; in fact, it's a healthy sign in most of the truly predictive sciences where everyone starts from the same basic pragmatic, empirical base line. But disagreeing on basics is something else: it indicates that the "science" is still in its highly formative, early stages of development and hasn't yet reached the level of predictability.

"Planned economies" such as that in the Soviet Union haven't succeeded and aren't succeeding. But some economists in the United States believe that they can achieve a planned economy by using computers.

One academic-type economist with whom I recently spoke claimed they had a valid computer model of the United States' economy. "In fact, we have fifteen models," he proudly stated.

Question that he couldn't answer: Which of the fifteen models is the most valid?

In other sciences, it is usually possible to conduct an "elegant experiment" to determine the validity of a hypothesis, theory, or mathematical model without disrupting a large segment of the real universe itself because of the interaction between the observer and the observed. Not so in economics. You've got to experiment with a whole

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economy. If you're wrong, it drastically affects a lot of human lives. Since the Soviets and the Chinese have lots of human lives to play with and a totally different philosophy of the individual, they can conduct such economic experiments. But they don't seem to be able to learn from the results.

In the United States, we may have succumbed to the charisma of the computer because it seems that some economists are trying to predict the economy of the country by crunching enough numbers through enough computers so that sooner or later they'll come up with results that match what has transpired. Note the use of the past tense. The economic system is so dynamic that by the time they figure out what it's really doing, it's doing something else. The people who get wealthy in such a dynamic system are those who manage to make a WAG (Wild Assumed Guess) at what's going to happen. It's no different than betting on a horse race except that the consequences can be much more lucrative or disastrous.

What's bothersome is not the old GIGO principle, but a variation of it: Garbage In, Confusion Out.

Tinkering with a multi-trillion-dollar economic system is like playing with a wild bull elephant in mating season. Or worse. Basically, the only way to solve the problem may be to let the elephant run free because there's no chain that will hold it in check for very long without harming the elephant. Some people may get trampled while the elephant thrashes. But fewer people may get trampled when the elephant runs than when he lurches about at the end of restraints, lashing out at those who restrain it. After all, the elephant has a very strong incentive and a powerful motivation to succeed. An incentive for personal success is a powerful element in any successful system.

Robert A. Heinlein described a computer-assisted economy in his 1942 novel *Beyond This Horizon*. He assumed a workable computer model of the world economy that was continually revised because computers everywhere were continually providing a data stream into the main computer. His economy wasn't really "planned," but "managed." Something like it might work some day in the near future when computers and networking truly become ubiquitous.

But it's going to be a problem getting some economists to consider such a system. Many of them exhibit a messiah complex—i.e., each is the only one who has the Truth. In talking with many economists and trying to get them to discuss various approaches, hypotheses, theories, etc. that are different and innovative, one usually runs into what Herman Kahn calls the "MEGO" phenomenon—"My Eyes Glaze Over." When detected, the MEGO phenomenon tells you that the guy thinks you've got an interesting idea, but *he's* not interested in it. It bores him. Worse yet, it may threaten him. It may undermine the foundations of his own career. This phenomenon exists with many scientists, not just economists. I run into it all the time in many places. I'm sure many of you do, too.

Maybe there is some truth in the theories of the Kondratieff cycle, the Kuznets Cycle, "trickle down," and the other economic hypotheses. But maybe

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we shouldn't try to run experiments in a "controlled" fashion with them here on Earth for the same reason we shouldn't run an experimental thermonuclear war. Could be hazardous to your health. (Observation: The economists don't seem to be hurt badly when the economy goes toes-up. Do they know something they're not telling anyone else?) And it's very difficult to get all the variables under control or accounted for. Maybe the ability to conduct meaningful experiments in economics is going to have to wait a few years until there are economic units operating in space. In fact, there may be some space colonies deliberately established to test economic theories.

Then perhaps economics will be able to pass the Swartzberg Test. ■

On Gaming

(continued from page 85)

gon from the period. But this, and the complexity of the design, make *Daredevils* a game for experienced players—not beginners. However, a sophisticated referee could make a game session go smoothly.

The scenario booklet that comes with the game contains four adventures: a simple two-page introductory situation called Fu Sung's Secret; a more detailed follow-up entitled Fu Sung's Revenge; a full-scale campaign in Africa called Black Claws; and a Phillip Marlowe/Sam Spade-style investigative adventure, On These Mean Streets.

Daredevils also comes with a 64-page rules book, referee's screen with tables and charts, character sheet, and dice.

In a more traditional RPG vein is *Ysgarth* by Ragnarok Enterprises (1402 21st Street NW, Washington, DC 20036). *Ysgarth* is a fantasy role-playing game in six booklets with between 20 and 30 pages of rules, charts, data, etc., per book.

Book 1 has information on creating your fantasy character. *Book 2* is about battlecraft—weapons and combat. *Book 3* covers the arcane arts of magic. *Book 4* details holy orders and religion in the fantasy worlds you play in. *Book 5* explains how a referee can create the fantasy world in which the adventures take place. *Book 6* is an introductory adventure—The Last Song of Hergest. Two supplemental books and character sheets are also provided.

Ysgarth provides much more variety and detail than the average fantasy RPG, but it does so with added complexity. Twelve different attributes make up your *Ysgarth* character—almost twice the number involved in other fantasy systems. Physical characteristics include constitution, strength, dexterity, and agility; mental characteristics include talent, intelligence, will power, and judgment; and social characteristics include zeal, appearance, charisma, and social standing.

Ysgarth is well organized and well written, and it's been described as more closely resembling a fantasy "simulation" than a game. ■

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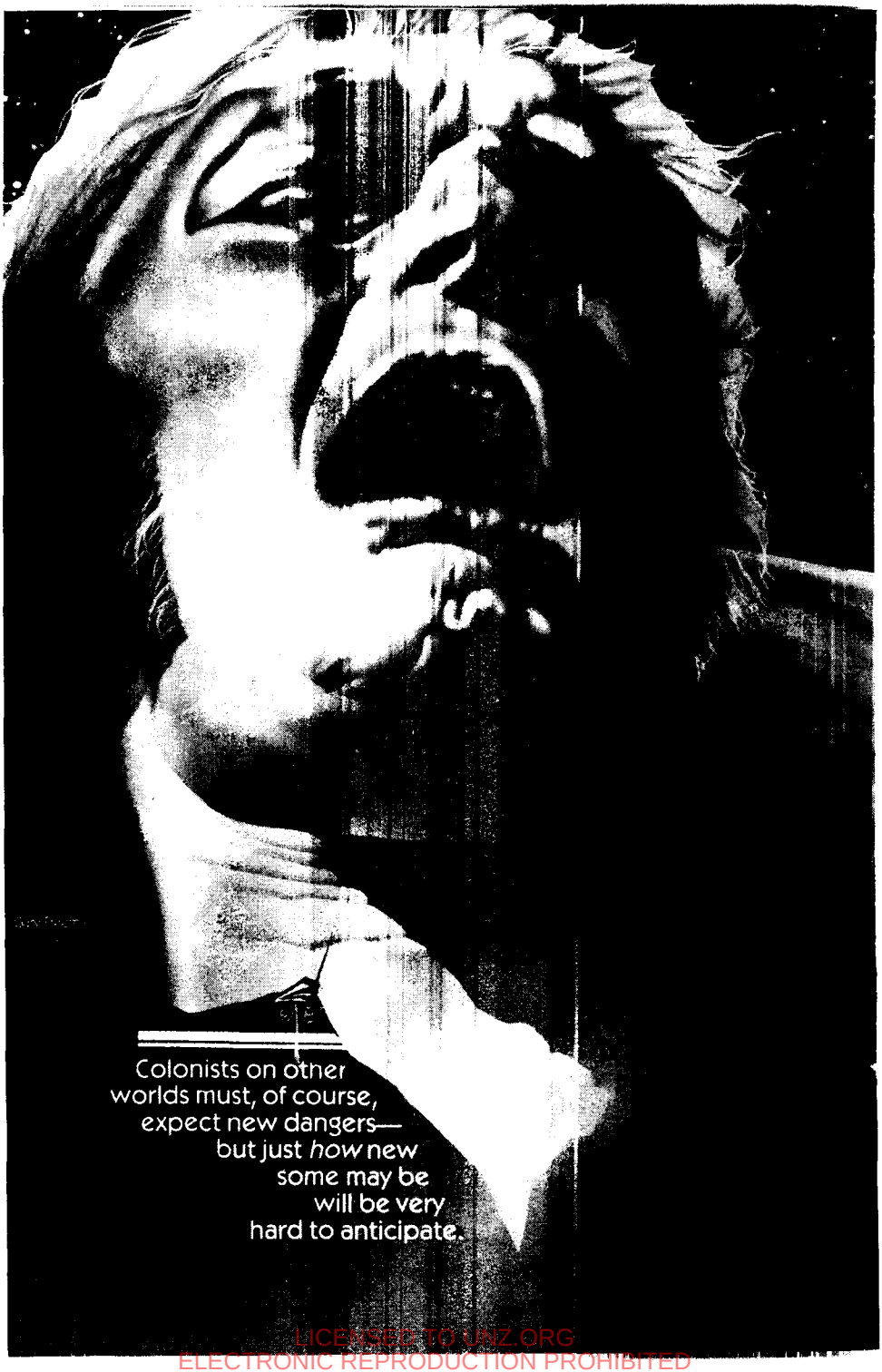

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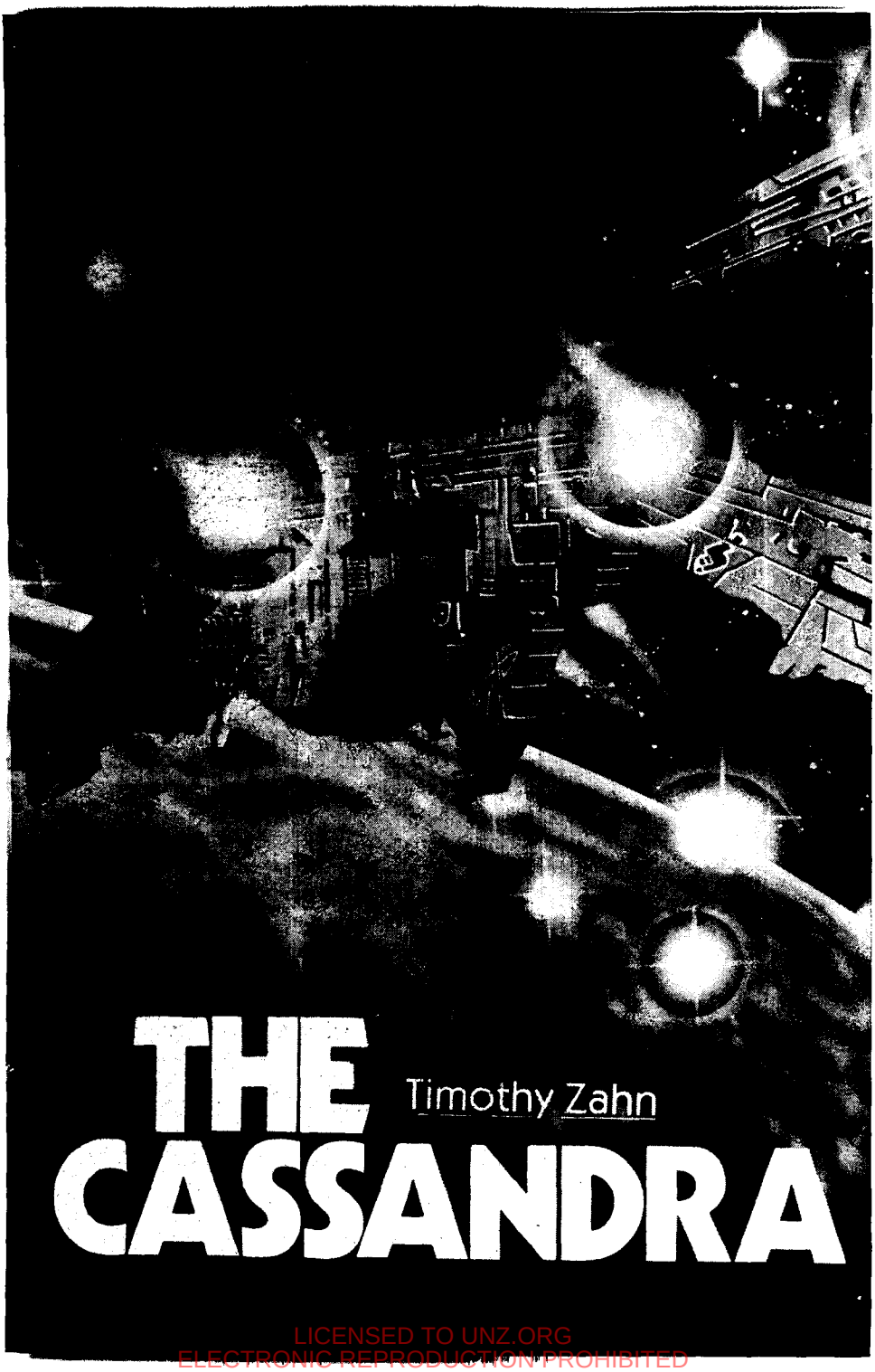

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It had been raining all morning the day Alban Javier left Aurora: a dull, cold, persistent drizzle out of a uniformly gray sky. Looking up from under the wide brim of his hat, Javier wished that the rain could have been accompanied at least by roiling thunderheads and crashing lightning—something that would have lent dignity to the event taking place. But perhaps it was more fitting this way, he told himself blackly. It was, after all, with a whimper instead of a bang that mankind was abandoning this world.

He had been scheduled to leave on the nine A.M. flight, but it was now nearly two and his part of the long line had barely made it past the landing field's inner gate. Behind him, outside the fence, the waiting crowd had abandoned any semblance of order and was pressing close to the mesh, taking advantage of the minuscule shelter offered by the fence's two-meter overhang. Javier glanced back at them from time to time, but always turned away quickly. Too many of the rain hats and poncho hoods had bits of pure-white hair poking from beneath them, and with the nearer ones Javier could see the emerald green of their eyes as well. It was something like looking in a multiple-image mirror, and it made him feel all the more uncomfortable.

Ahead of him, the line shuffled forward a half meter. Picking up his single travelbag—all that the colonists were permitted to bring—Javier moved up and focused on the building into which the line ultimately disappeared. A good hundred meters away yet. Still, a considerable number of the city's residents had left in the past week. Perhaps the inevitable trance would hold off long enough for him to escape finally into space.

It didn't. He had, in fact, covered barely five more meters when the familiar tingle rippled through his body, and as his muscles locked in place the gray rain faded from before him. . . .

A fireball becomes a river of flame racing through a dark, narrow corridor, erupting finally from a wood-shored entrance to blacken the grassy knoll above. The screams from within fill the air, but even as swearing rescuers plunge into the mine they are fading into the silence of death. Those still alive are brought out first, their agony muted by drugs. The rescuers who carry out the dead are no longer swearing. All are grim-faced; some are crying. The blackened bodies pass closely enough to touch. . . .

And Javier was back on Aurora, standing in the rain with knotted muscles and a throat full of nausea. Behind him someone—a younger teen, probably—was sobbing with reaction. Ahead of him, the people had bunched together a bit more closely, leaving a small bubble of space around him, as if he were the carrier of some loathsome disease. He didn't bother to turn around; he knew that his own inner horror was mirrored in a hundred pairs of green eyes, and he had no desire to see it. Even misery could get tired of company.

With a shuddering sigh he slid a wet hand under his collar and massaged the taut neck muscles there. One final going-away present, he thought dully; with love, from Aurora.

The cubicle euphemistically referred

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to as the kitchen manager's office was about the size of a king-sized coffin, Javier decided as he stood silently in the half-meter of space between the front wall and the cluttered desk. Wedged into a chair across the mound of paper was a man so fat that it was hard to understand how he had ever gotten into such a limited area. Unbidden, an irreverent thought flickered through Javier's sense of futility: that Hugo Schultz had been placed behind the desk as a child and allowed to grow into his current position.

Schultz looked up from the application he'd been reading and fixed Javier with a pig-eyed stare. "You didn't put down what job you wanted," he said, his voice just loud enough to cut through the sounds of the hotel kitchen that the cubicle's walls made only token effort to keep out.

"I'll take anything that's open," Javier said simply, matching the other's volume.

Schultz nodded. "Uh-huh. I see you've got Earth citizenship. You born here?"

A lie would be so easy—and so useless. Javier's entire public information file was available via a single phone call, should Schultz choose to check on it. Besides, to anyone who had followed the events at the frontier over the past few years, his hair and eyes were a dead giveaway. "No, I was born on Aurora."

"Thought so," Schultz grunted. "You're a Cassandra, then?"

Javier winced at the term, but its use was far too widespread these days to be avoided. "Yes."

Schultz grunted again and studied the application some more. "A master's degree, no less. You get that on Earth?"

"No, on Aurora."

"I thought all the schools went when the rest of the planet fell apart."

"They did. But I was one of the first of my generation—the first generation of Cassandras. The society didn't begin its collapse until we entered the labor force, and by then I had my degree." He shuddered slightly at the memories. "I stayed on Aurora to try and help. Six months later Earth ordered the planet evacuated."

"At *Aurora's* request." The words were heavy with accusation.

"Yes," Javier acknowledged, making no effort to defend Aurora's leaders or their decision. On some worlds of the Colonia, he'd discovered, the stigma of being from a failed colony was almost as bad as that associated with his Cassandra visions, and he had long since tired of both fights.

Schultz's expression didn't change, but his voice softened a shade. "Why? What were you running from?"

"Ourselves. Each other. The visions." Javier shook his head. "You can't understand what it's like, Mr. Schultz. Never anything but people dying—usually on a massive scale, and always so close you can practically smell them."

"But they don't come true, do they? That's what I heard, anyway."

"Enough do," Javier said. "A few percent, I suppose. But that doesn't really help. All it does is add uncertainty to the whole thing, like watching a laser being aimed at someone and not knowing whether it's charged or not."

"Did leaving Aurora help?"

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There it was at last: the question that, in one form or another, everyone eventually got around to. *Have the trances stopped coming?* Again, the temptation was to lie; again, he knew it would be useless. "Not really. Scattering us around the Colonia eliminated the group trances, but that's about all."

"Those the ones where someone had a seizure and half the Cassandras in the city joined in?"

"Sort of," Javier said carefully. They were treading on dangerous ground here. He would have to watch what he said.

"The story goes that every time the dust cleared from one of those you had a bunch of dead people and a mess of wrecked equipment." Schultz's steady gaze had challenge in it.

Javier understood; it was a roundabout way of asking another familiar question. "The deaths came about mainly when people driving or working heavy machinery weren't able to stop before the trance began. But we always get a couple seconds' warning, so for most jobs there really isn't any danger, either to ourselves or anyone else."

"You were pretty stupid to let Cassandras do that sort of work."

Javier shrugged. "We didn't have much choice. The entire third generation had the curse, and the work force desperately needed us. Anyway, the deaths and damage weren't all that devastating in themselves. It was the panic and fear that went with all of it."

Schultz held his gaze for a moment and then dropped his eyes to the application again. Javier waited silently, listening to the muted clatter of dishes around him and trying to ignite at least a spark of hope. The effort was futile. Schultz was far too smart not to have realized that someone with Javier's education wouldn't be looking for work in a hotel kitchen unless he was desperate. Bracing himself, Javier waited for the inevitable turndown.

"All right," Schultz grunted abruptly. "You can start on dishwasher and cleanup duties. Our stuff's not very fancy—sonic washers and brooms—but it's not likely to get away from you, either. If you're carrying a stack of dishes or something and it happens, put them down, pronto. And don't tell any of the other kitchen staff where you're from. They're not too bright, most of them," he added, anticipating Javier's obvious question, "and probably won't connect the hair and eyes to Aurora."

"I . . . yes, sir. Thank you, sir," Javier said, thrown off balance by the unexpected response.

"Sure. One other thing." Again the pig-eyes bored into Javier's face. "How often do you get these trances of yours?"

"Two or three times a week, usually, in a big city; maybe once a month in a less populated area."

"What's your accuracy rate?"

"About five percent. All the ones that do come true seem to happen within twenty-four hours of the vision."

"One in twenty. Not too good, is it? So okay, here's the deal. You get a vision, you keep it to yourself. I don't want to hear about it, and I don't want the staff to hear about it. Life in New York is hectic enough without doomsayings that probably won't happen. Got that?"

"Yes, sir."

"Good." Abruptly, Schultz raised

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his voice in a shout that made Javier jump. "*Wonky!*"

A moment later the door at Javier's right popped open and a thin, weasel-like face peered in. "Yeah, boss?"

"This is Javier; he's on cleanup duty. Show him around and get him started."

"Sure." Wonky tossed a broken-toothed grin at Javier. "Let's go, kid."

"You like the boss, Javier? Huh?" Wonky asked as they left the cubicle.

"He seems very fair," Javier answered cautiously.

Wonky nodded vigorously. "Yeah, sure is. Friend of mine, good friend. Knew him in Jersey, couple years ago. He told me if I ever needed a job just come to him. So I did."

Javier nodded. Wonky was a thin youth with darting eyes and quick movements. He had probably grown up on the city's streets, his scars and missing teeth the dues of survival. Such people hadn't existed on Aurora, but Javier had met many in the old cities of Earth. None of the younger worlds of the Colonia, he had once heard, had been in existence long enough to develop the vast social and economic disparities of the mother world. Give them time, though, and the slums would come.

He shook off the mood. It was probably natural—maybe even inevitable—for a Cassandra to lean toward morbid thoughts. But such borderline self-pity should not be overdone, especially on a day like today. He had a job!

Now if only he could keep it.

The first few days went well. The work itself was, of course, childishly simple, and Javier quickly learned all that Wonky could tell him about the kitchen and its operation. Of the hotel served by the dining facilities he learned nothing. Wonky's duties as busboy ended at the edge of the dining room; so, effectively, did his world.

Javier threw himself into his job with a will and efficiency that caused many puzzled looks and—inevitably—snide comments from his fellow workers. The strange coloring of his hair and eyes probably also slowed their acceptance of him, but if anyone actually identified the newcomer as a Cassandra he kept that knowledge to himself.

Strangely enough, Wonky seemed immune to the general aloofness and would often hang around Javier during slow times. His conversational range was limited, but Javier learned many helpful tips about living in the big city from him. He was grateful, too, for the company.

Luck was with him in another guise, as well: his first three visions occurred outside of working hours, away from the hotel. Two happened in the tiny run-down room he had rented a few blocks away, the other as he was walking home one afternoon. As always, they were images of disasters: an aircar crash, an earthquake, and a flash flood. And as usual, they did not come true, at least not as far as a check of the news media could establish. Years ago, Javier had believed he would get used to the visions, as one could get used to nightmares or scenes of violence on the evening news. Now, though, he knew differently. There was an overpowering immediacy to the disasters he was forced to witness, an accuracy of sensory detail that made them as real to him

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as anything else in the world. To deny the visions at any level would require similar denial of all reality, and Javier wasn't yet desperate enough to yield to insanity.

He'd been at work for almost a week when Wonky came in from the dining room with a load of dishes and the look of a kid with a secret. "Hey, Javier, guess what I just saw in the dining room."

"What?" Javier asked. His eyes and most of his attention were on the sonic washer, which had a tendency to drift off its proper frequency and rattle the dishes.

"There's a girl out there who looks just like you," the other grinned.

The washer was suddenly forgotten. "What do you mean?"

"You know—got the same hair as you. Same green eyes, too. I saw her up close."

Another Cassandra? *Here?* "Show me, will you?"

Wonky led the way to the swinging doors that opened into the dining room. Opening one of them a crack, he gestured beyond it. "Next to the wall."

Javier squinted through the opening. Details were hard to see at that distance, but he was almost sure—

She turned in his general direction for a second and he stiffened. Pulling off his apron, he tossed it to Wonky. "I'm going to talk to her. Cover for me, okay?"

"Hey, wait, you're not supposed—" The rest of Wonky's protest was cut off by the closing door. Feeling horribly conspicuous, Javier threaded his way through the maze of tables. "Excuse me," he said as he reached the girl's side. "Are you Melynn Uhland?"

She glanced up, then took a longer look. "Yes. Do I know you?"

"I doubt it. My name's Alban Javier. I went to Aurora Northern, too, but I was a year behind you. Mainly, I know your picture from news reports of your work with Dr. Rayburn."

"What can I do for you?" she asked coolly.

"Uh—may I sit down?" This wasn't going quite as Javier had expected it to and he was beginning to get flustered.

She hesitated, then nodded curtly. He sank gratefully into the seat at her right. "I—well, I just wanted to find out what's happening in your work," he told her. "The articles I've read don't really say much."

"The final report won't, either," she said, her voice strangely flat. "At least, it won't say what you want to hear."

"What do you mean?"

"I mean we haven't found a way to stop the visions."

Javier froze. "But . . . you said *final report*."

"That's right. We're quitting."

He started to speak, but no sound came out of his suddenly dry mouth. He tried again. "You can't *do* that. I mean—look, we've been living with this for fifteen *years*, some of us. We've had friends die and other friends go permanently psychotic. We can't stop until we find a cure."

"What do you mean, *we?*" Melynn snapped, green eyes blazing. "*I'm* the one who's been living in Rayburn's hellhole, not you." She glared at him for a moment as he sat there, speechless. Then, lowering her gaze, she passed her

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hand across her forehead; and when she again raised her eyes the anger was gone. "Alban," she said quietly, "I know what you're going through. Just because I was working with Dr. Rayburn doesn't mean I didn't get my share of the fear and misunderstanding everyone dumps on us. I did. And the job . . . it was ten times worse than Aurora. The staff spent half their time trying to learn what triggers the trances, and the other half looking for a way to suppress them." She shook her head. "Nothing worked, but they tried everything. I had to live through changes in diet, environment, biorhythm—I don't remember all of them. Some of them—a lot of them—made either the vision or side effects worse. I've lost ten kilograms since we started, and been on the brink of a nervous breakdown twice. Others of us weren't that lucky—two of our original eighteen are dead, and another four might as well be. I've been Dr. Rayburn's only test subject for three months now; everyone else had to drop out. Alban, I want to find out how to stop the trances; I want it so badly I dream about it. But I can't do any more. I've paid my pound of flesh. It's up to someone else now."

"I'm sorry," he said. Dimly, he was aware of how inadequate the words were, but at the moment another, more urgent thought was uppermost in his mind. "Tell me," he asked carefully, "*did* they ever figure out what triggers the visions?"

It was as if a thin glaze of ice had dropped over the emerald of her eyes; and in that moment Javier knew that she, too, knew the truth. "No," she said in a low voice. "And I doubt they ever will."

He nodded, trying to dislodge the lump that had formed in his throat. "You could have made it easier on yourself, you know, if you'd just told them."

Her smile was bitter. "You don't find enough hatred directed toward you, Alban? You want to try living among people who know how your visions come to you?"

"No." Javier glanced at the people sitting nearby, but if they were listening they gave no sign of it. "I'm sorry; it was a stupid comment."

"That's all right." She touched his arm. "I'm sorry, too—I didn't need to be sarcastic. I'm just very burned out right now."

"Any way I can help?"

She shook her head. "Thanks, but no. I'm just passing through, actually—I'm heading up to the most desolate part of northern Newfoundland I can afford to get to." She smiled faintly. "My first choice was central Australia, but Dr. Rayburn's budget couldn't stretch that far."

Javier nodded. "I guess I'd better get back," he said. "Thanks for talking to me."

She caught his wrist as he started to get up. "Look, Alban, I'm sorry I—well, I know how much you and everyone else has been counting on us. And we *did* turn up one bright spot: the virus that linked into our parents' chromosomes apparently requires a naked protein from the Auroran biosphere to make its linkage properly, and the pseudogene it forms is highly recessive besides. That means that unless you marry another Cassandra your children won't have it; and even if you do the pseudo-

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gene will probably break off and disappear before your grandchildren can inherit it."

He swallowed, unsaid, the first words that came to mind. If she wanted to see that as a bright spot it wasn't his place to burst her bubble. "Well, that's something," he said instead. "I—good luck with your trip, Melynn; I hope it helps you."

"Thanks. Good-bye, and good luck to you, too."

He made his way back to the kitchen through the sea of covertly staring eyes and returned to work, feeling a familiar numbness settling over his brain. Somewhere deep inside him, he knew, part of the drive that kept him going had died. He had never honestly admitted to himself just how much hope he had been putting in Dr. Rayburn's work; the true quantity was now painfully clear. Rayburn was the last major researcher still working on the Cassandra trances. If he was giving up, then that was it. The visions would be with Javier now until his death, ending forever any chance he might have had to live a normal life. A wife and children . . . he almost wished Melynn would be able to keep such a naive hope. But outside Rayburn's lab it was unlikely to last. The real world was a sobering experience for social outcasts.

Somehow Javier managed to make it through the day, and by evening his bitterness and frustration had abated somewhat. Many people throughout history, he told himself as he walked home, had survived without hope; he could, if necessary, do likewise. Besides, he seemed to be lucky these days. Maybe luck would serve him where hope had failed.

Two days later, his luck ran out.

He was sweeping the kitchen floor when the two-second warning came, and he had just time to step close to a wall before his muscles locked in place and the world faded away. . . .

Lying on its side is the tangled wreckage of a tube train, squeezed between the tracks and the tunnel wall. Smoke and fire are everywhere, the crackling of flames mingling with the screams of the injured and the shouts of rescue workers. From outside the tunnel comes a barely audible roll of thunder, the sound strangely incongruous in the midst of the carnage. An eddy in the air currents momentarily clears the smoke from one car's number plate: 1404. From somewhere inside a scream goes on and on. . . .

"Hey, Javier! Hey!"

The voice came from far away, scared and insistent. Gradually, the train wreck faded from sight. The usual wave of nausea rose into Javier's throat, and he screwed his eyes shut as he fought it down. His muscles trembled with tension and adrenaline shock, and his head ached fiercely. Opening his eyes carefully, he found himself looking into Wonky's anxious face. "I'm okay, Wonky," he croaked through dry lips. "Don't worry."

The weasel face relaxed only fractionally. "What happened, kid? You looked like you were seeing a ghost."

"I saw a train wreck," Javier said. The headache and nausea were beginning to recede now. A violent shiver swept through his body, scooping up

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tension and leaving weakness in its wake. "It's okay, though," he added as Wonky's eyes widened, "it happens to me a lot. The trance only lasts a few seconds."

"Gardam! You one of them whatchya-say—fortune-tellers? What'd you see?"

Javier's hands ached, and he suddenly realized he was still squeezing the broom handle. "I'm not a fortune-teller. I just see these things sometimes. Look, I'm not supposed to talk about it."

"What'd you see?" Wonky persisted.

Javier sighed, but he lacked the emotional energy to argue. Haltingly, he described the vision in as much detail as he could stand. "Now please don't tell anyone else about me, okay?" he said when he had finished. "Mr. Schultz told me not to—"

He was cut off by a sudden grip on his arm. "Hey! The fourteen-hundred cars are always on the Paterson train —that's the one Mr. Schultz goes home in!" Wonky flicked a glance at the wall clock. "Gardam, he's gone already. C'mon, we got to stop him!"

"Wait a sec," Javier protested, but it was too late. Wonky's wiry body was a lot stronger than it looked, and before Javier could break loose he found himself outside in the hot, muggy air.

"Hold it," he tried again. "Mr. Schultz told me not to tell him about any visions I saw."

"You just gonna let him die?" Wonky snorted. He took off through the late-afternoon crowd of pedestrians, moving like a combination jackrabbit and bulldozer. Javier ran after him, and managed to catch up again two blocks later.

"Wait, Wonky, hold on," he said, trying not to pant. "Look, it may not come true. Probably won't, actually. Hey, remember it thundered in the vision? Look, no thunder!"

It was no use. Wonky had gotten it into his head that his boss/friend was in danger and no one was going to stop him from delivering a warning. Groaning inwardly, Javier followed, wondering what he was going to do.

They reached the tube station minutes later and Wonky, who obviously was familiar with the layout, headed off to the left. Shivering as sweaty skin met the air-conditioning, Javier plunged through the crowd after him. A low rumble made him glance back at the entrance before he'd gone very far. He shivered again, this time not from the cool air, and hurried on. Outside, it was starting to rain.

Hugo Schultz was easy to spot, his huge girth making him stand out among the other commuters. Javier hesitated, but Wonky showed no signs of uncertainty. He caught up to Schultz just as the latter was about to step into a waiting train. Pulling him out of line—no mean feat—Wonky launched into an animated monologue. From his position Javier couldn't hear what was being said, but Schultz's face quickly clouded over with anger. Twice he tried to pull from Wonky's grip, but the little man hung on grimly, letting go only when the train began to move down the tunnel. As it passed, Javier noted the number on one of its cars: 1404.

He looked back to see Schultz bearing down on him, face livid with rage, with a relieved but puzzled-looking Wonky in his wake. "Javier!" the fat man bellowed. "I thought I told you to keep

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your damned tricks to yourself. Now you've made me miss my train, and you've got Wonky all in a lather—''

''Boss, he saved your life,'' Wonky said.

''Mr. Schultz, believe me, I tried to tell him—'' Javier began.

''Shut up! You're fired. *Both* of you—got that, Wonky?''

Wonky's jaw dropped, and he started to protest.

The words never came. From down the tunnel came a hideous crash.

Someone in the crowd screamed and someone else began shouting something, but Javier didn't really hear them. Turning, he started off through the crowd, hoping desperately to reach a wall or doorway where he'd be safe. But it was too late; and even as he took his first few steps his body went stiff. Through the vision of an exploding starship that danced before his eyes, he dimly felt the jostling of the crowd pushing him off balance. An instant later, the universe went black.

He woke up—or, more properly, returned to a state of relative consciousness—four or five times in the next few hours, as nearly as he could later piece events together. It was a foggy sort of awareness, distinguished from sleep mainly by the throbbing pain in arms, chest, and head. Occasionally he heard voices, indicating there were others in the room with him. Sometimes all he could hear was groaning.

It was the periods between those times that nearly drove him insane.

Only once before in his life had he ever had even two visions come one right after the other; now, they were coming in strings.

Two aircars collide violently just short of a rooftop landing pad, obvious victims of a guidance computer malfunction. One slides over the edge and falls two hundred stories. . . .

An explosive decompression aboard an orbiting space colony. Three are killed instantly, seven others suffocate before help can reach them. . . .

Screams in an unknown language are swallowed up by the roar of an erupting volcano. The rain of ash and flowing lava cut through a jungle village, obliterating it completely. . . .

A fleet of unidentifiable starships fights a short but violent battle with a planetary defense force, destroying it to the last ship. . . .

The starship battle was the worst of the visions, its intrinsic horror stretched agonizingly by its sheer persistence. Again and again Javier was pulled back to the scene, forced to watch as the victors, apparently not satisfied with the deaths they had already caused, proceeded with cold-blooded efficiency to burn off the world they had defeated. From space the expanding rings of nuclear flame were clearly visible; at ground level they were the height of redwoods and the brightness of the noonday sun. For once, no one screamed in pain. No one had time.

Finally—finally—the hurricane of death subsided. With an effort, Javier swam his way back to consciousness. The first thing he saw when his eyes opened was Wonky's face.

''Where am I?'' he whispered, his throat very dry.

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"Hospital," Wonky told him. "Ward Two. How you feel?"

"Terrible. You've got to help me get out of here."

"You're not well enough," Wonky protested. "You got kinda trampled when you fainted at the station. You should wait till morning, anyway—it's pretty late."

"I don't care. If it starts up again I'll go crazy. Never mind," he added, seeing Wonky's puzzled expression. "My clothes must be here somewhere. Find them, and then hunt up a doctor. I'll sign any release they want. But I have to get out."

For a long minute Wonky stared at him, brows tight with thought. Then he nodded once, curtly, and began to search among the ward's lockers. He found Javier's clothing, and after being assured that Javier could get into them alone, went in search of a doctor. Javier dressed slowly, his body aching with every movement. A radio was playing softly at the nurses' station at the end of the room, and he paused once to listen as a report of interstellar news came on. The doctor Wonky dragged back with him proved stubborn, but in the end was persuaded to produce the necessary papers, and a few minutes later Javier was out on the street. Supported by Wonky, he headed toward his apartment building. They just made it.

Javier slept for nearly ten hours; a deep sleep, untroubled by visions. When he awoke he lay quietly, staring at the ceiling and thinking about what he'd seen and heard. After a while, he slept again.

By the time he woke up he had made his decision. He showered, ate the last of the packaged food he had in the room, and wrote a long letter. Then he began packing.

Wonky arrived before he had finished. "Hi, kid, how you feeling?" he asked as Javier offered him the room's only chair.

"Better," Javier said, sitting on the edge of the bed. "Thanks for helping me home last night."

Wonky shrugged. "Yeah . . . look, Mr. Schultz sent me to see you."

"He was going to let me come back, but then changed his mind. Right?"

Wonky seemed taken aback. "How'd you know?"

"I expected it. Word of my vision got around the kitchen, probably, and the people don't want to work with me. Happens all the time."

"It ain't that they don't like you, you know. They're just kinda scared."

"I know." Javier looked at him thoughtfully. "What about you, Wonky?"

"You saved the boss's life. That was a good thing to do. I don't think it's right to fire you just 'cause some of the others are scared. I told him so."

"Thanks for backing me up. Did you get your own job back?"

"Oh, sure. Mr. Schultz doesn't mean it when he fires me. He told me to give you this." He fished a bulky envelope from his pocket and handed it over. "He said it was all he could do."

Inside the envelope, in well-worn bills, was about three hundred dollars. "That was very kind of him," Javier said, surprised by the gift. "Please thank him for me."

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Wonky glanced at the travelbags. "You leaving town?"

"Yes. I'm getting as far away from people as I can. Northern Maine, maybe." Thoughts of central Australia flashed briefly through his mind.

"How come?"

Javier hesitated. This was not the time nor the place, he told himself. But the secret had been bottled up within him for too long. "Wonky, have you wondered how it is I can get these visions, wondered what it is that causes them?"

"Naw, not really. Mr. Schultz said it's a kinda curse."

"It is indeed. But it's a curse with a very simple basis." He closed his eyes briefly. "Death."

Wonky's eyes narrowed. "I don't get it."

"It's painfully simple. Someone fairly nearby dies, and that event triggers a vision. That's what happened at the station—the train wreck started a trance, and I got trampled. At the hospital, with crash victims and others dying all around me, I got visions strung together like previews of Armageddon."

He stood up and went to the window. "It was the group trances on Aurora that finally tipped me off," he said, as much to himself as to Wonky. It felt good to finally let it all out. "Always there was one death in the obit list that wasn't connected to the accidents—that was the death that started the whole thing. A few Cassandras would be affected; one, maybe, would be driving a car and would run down a pedestrian. Another death, more trances. With enough Cassandras doing dangerous things it could have gone on forever." He sighed. "I think the old philosophers must have been right. Human life—maybe sentient life in general—is more important to the universe than we like to think these days. Somehow, the two instances of death—the triggering one and the ones in the vision—seem to form a link through time and space, a bridge that we Cassandras can somehow travel. Maybe because death takes the person out of time, so that all deaths are in some way congruent— I don't know. All I know is that it happens. The philosophers can play games with the semantics."

Wonky had been listening silently —probably, Javier thought, not really understanding. But now he spoke up. "Wait a minute. Mr. Schultz and you both said that most of the things you see don't ever happen. So what's this bridge thing you're talking about?"

Javier didn't turn around. He didn't want Wonky to see his face. "Mr. Schultz is wrong, like all the rest of us have been. Maybe we didn't want to believe it . . . but it's the only way this can possibly make sense. You see, just because a vision isn't fulfilled nearby doesn't mean it isn't fulfilled *somewhere*. We just never— I mean, there are just too many *worlds* out there that we don't hear much from." He bit his lip. "As I was getting dressed at the hospital I heard a report that had come in from Centauri, saying somebody important had been killed in an aircar crash. They gave enough details that . . . well, I saw the crash, Wonky, saw it almost a week ago. But if that VIP hadn't been in it, I'd still think the vision hadn't come true."

He turned back to face Wonky. "No, Wonky. Every one of those damnable

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visions must come true. Maybe some of them haven't, yet. But they will."

He stopped; not necessarily waiting for a response, but simply out of words. "I don't get it all," Wonky said slowly. "But I guess you know what you're talking about. You're a lot smarter than me, anyway." He hesitated, then stood up and held out his hand. "Good luck."

A few minutes later Javier was back on the street, trudging towards the tube with his travelbags. He walked mechanically, only dimly aware of his surroundings, his mind numbed by emotional fatigue. On the way he dropped his letter in a mailbox; Dr. Rayburn would receive it in a day or two.

Wonky hadn't understood, of course. How could he? To know someone had died each time you were awarded the dubious privilege of watching someone else die—it was too far out of his experience. And he probably wouldn't have been able to live with the idea if he *had* understood it.

For Javier, though, there was no escape, either from the knowledge or its consequences. He could leave the city now, but he knew he'd have to return. Even if Dr. Rayburn believed him, experiments and massive data searches would have to be performed to prove it to the rest of humanity. And that would be only the beginning, because the ultimate goal was still to control the trances and their side effects. More experiments would have to be done, experiments like the ones that had nearly destroyed Melynn Uhland and her friends. It would require more volunteer Cassandras . . . and Javier knew who the first of those would have to be.

Himself.

The thought of it was terrifying—his hospital experience multiplied by a hundred. But he had no choice. The truth had to be told; the Cassandras *had* to learn, at whatever cost, how to use their curse.

Because Earth was going to need all the resources she could muster. Glancing involuntarily at the sky, Javier shivered as he remembered that terrible hospital vision. Somewhere out there, sometime in the future, a war fleet powerful enough and vicious enough to burn off an entire planet was going to win a great victory. If the race that owned that fleet was expanding their own empire into space, they would someday reach the Colonia . . . perhaps very soon.

And if the cost of developing the Cassandra ability into a weapon against that threat was enhanced public hatred and the loss of a few lives, then so be it. It would, Javier knew, be worth such a price.

Even if one of those lives was his own. ■

● To the shame of mankind, it is well known that the laws which govern our games are the only ones which are completely just, clear, inviolable and enforced.

Voltaire

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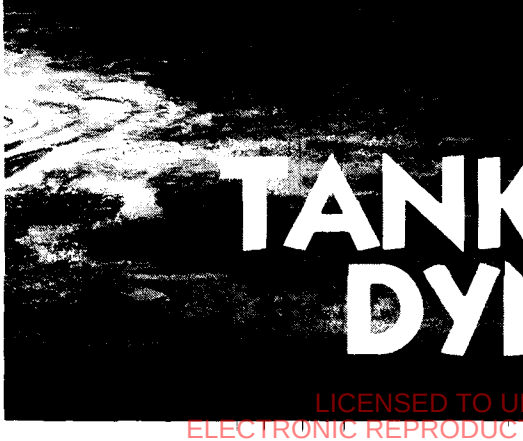
TANK-FARM DYNAMO

David Brin

It's common to talk of space development as if it will be done by governments or private enterprises. Real situations are likely to involve both—and the interactions between them present their own problems.



1.

"They finally fired Bylinsky."

I was up to my knees in agri-sludge, a frothy brown mess at the bottom of my personal greenhouse tank, when I heard the remark. For a moment I thought I had imagined it.

Your hearing plays tricks when you're wading around in mucky water, barely held to the floor by under a hundredth of a gee. I was groping in the goo, trying to find whatever had gummed up the aspirator. My breath blew up little green and brown droplets that hovered in front of my face for long seconds before slowly settling down again.

"Ralph! Did you hear me? I said Bylinsky's OUT!"

I looked up this time. Don Ishido, our communications and operations chief, hung halfway through the aft hatch of the greenhouse twenty meters away. He was watching my reaction, maybe in order to report to the others exactly how I took the news. Probably there was money riding on it.

I nodded. "Thanks, Don. Bylinsky's days were numbered. We'll miss him, but we'll survive."

Ishido smiled faintly. He must have bet on my poker face. "What do you want me to tell the others, boss?"

I shrugged. "We're still a tank-farm. We buy 'em and store 'em, and later we'll all get rich selling 'em back for a profit."

"Even when they cut the water ration?"

"There'll be a way. We're in the future business. Now get out of here and let me finish my recreational farming."

Don smirked at my euphemism, but forebore comment. He ducked out,

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leaving me alone to my "recreation" . . . and my worries.

After clearing a clump of gelatinized algae from the input ports, I climbed onto one of the catwalk longerons rimming the pond and turned on the bubbler. The air began to fill with tiny, green, superoxygenated droplets.

I leapt toward the aft hatch and sailed across the huge chamber to alight near the exit hatch. There I stowed my waders, and looked around the greenhouse to make sure it was ready.

In the ten years I've been living in tanks I doubt I've ever entered or left one without blinking at least once in awe. The hatch was at one end of a metal cylinder as long as a ten-storey building is tall, with the diameter of a small house. The walls were stiffened by aluminum baffles which had once kept a hundred tons of liquid hydrogen from sloshing under high stress. That ribwork now held my greenhouse ponds.

The former hydrogen tank had a volume of over fifty thousand cubic feet. It, and its brothers, were just about the largest things ever put into space. And this one was all mine—my own huge garden, to putter around in during off-duty hours, growing new types of space-adapted algae and yeasts.

I passed through the yard-wide hatch into the intertank area between the two main sections of the External Tank. In the middle the intertank was only four feet across.

Looking back into the garden tank through a tinted port, I pressed the button to let the sunshine in.

A bright point of light blossomed at the opposite end of the cylinder, to let in mirror-focused sunlight through a fused quartz window and strike the cloud of rising bubbles.

I stayed by the window long enough to watch the rainbows form.

The intertank hoop connects the big and little parts of the great External Tanks, or "ETs," as we call them. The smaller cell had once contained 550 cubic meters of liquid oxygen. These days I stored gardening tools in it.

Not a day had passed, in the last five years, in which I hadn't wished someone on Earth would recognize the waste, and come and take my tool shed away from me—to be used in some grand and wonderful plan.

Now they were trying to do just that, but not in a way I cared for at all.

"*Boss? You still there? There's a telex from J.S.C. coming in.*"

I grabbed the big steel beam that had once borne the thrust of giant, strap-on solid rocket boosters. Now it served as a convenient place to put the intercom.

"Ishido, this is Rutter. I'm on my way. Don't let them sell us for scrap till I get there. Out."

I put on my hardsuit, carefully double-checking each seal and valve. The lock cycled, and I emerged into vacuum, but not blackness.

Overhead the Earth spanned the sky, a broad blanket of browns and blues and fleecy white clouds. From just five hundred kilometers up, you don't see the Earth as a spinning marble in space. She covers an entire hemisphere, filling half the universe.

I drifted, but after a minute my boots touched the metal of the tank again. The same faint microgravity that held my

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pools inside the garden worked here on the outside.

The tank was the next to last in a row of forty of the great cylinders, nestled side by side in a long row. A parallel deck of fifteen huge tanks lay about sixty kilometers overhead, linked to this collection by six strong cables. Twenty meters away from where I stood, one of the half-inch Kevlar tethers rose from its anchor point, a mirror-bright streak toward the planet overhead.

Sometimes I could make out B Deck without aid—a tiny rectangle about an eighth the apparent diameter of the moon—against the bright bulk of the Earth. When we crossed the terminator, the tanks in Group B sparkled like gems in Terra's sunset tiara.

Today I hadn't time to look for B Deck. The Feds had finally fired Edgar Bylinsky, the Tank Farm's last big supporter in NASA. If we thought times were hard before, they were going to get worse now.

"*Ralph?*" It was Ishido's voice again, now coming over my suit radio. "*We've got the telex. I think this is the big one.*"

I pushed off toward the control center. "Okay, what's the news?"

"*Uh, they're moving fast. Pacifica's coming in with a couple of official bad news boys.*"

I could guess what the bad news boys were coming to tell us. They'd say they were here for "consultations," but actually it would be to tell us that Uncle Sam wasn't going to sell us any more water.

"Don, when are the bad news boys due?"

"*E.T.A. about an hour.*"

"I'll be right in."

Another hop took me to the entrance to the control tank. It was sheathed in layers of plating cut from dismantled ETs, to protect the crew during solar proton storms.

While waiting for the airlock to cycle, I looked up at the Indian Ocean, where they used to dump our tanks back at the beginning of the shuttle program, before we started buying and storing them up here.

For years ours had been a lonely and expensive gamble. Now we had proved our point. Proved it too well, it seemed.

They let us get a monopoly, and now they want to break us, I thought. *And they might succeed, if they cut off our water.*

We had safeguarded the Key to Space for them, and expected them to be grateful when they realized its worth. We should have known better.

2.

In the beginning there was the space shuttle. Never mind what came earlier. Before the shuttle, space was a place for robots and daredevils.

With tight budgets and all, the Space Transportation System has stayed fundamentally the same. A big, complex, manned orbiter is launched from Canaveral or Vandenburg, strapped to two solid rocket boosters and one huge fuel tank carrying 770 tons of cryogenic propellants for the shuttle main engines. The engines are part of the orbiter, so they can be brought home and re-used. The solid boosters drop off minutes after liftoff and are recovered.

But until our group came along, the huge external tanks were simply dumped,

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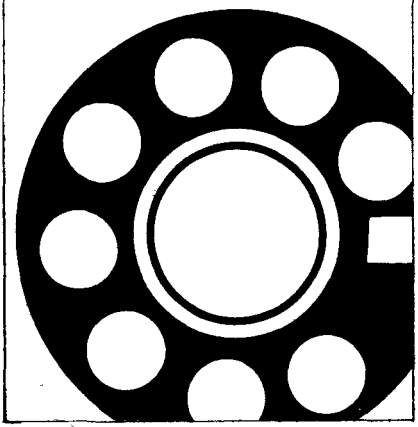

after fueling the shuttle to almost orbital velocity.

Once upon a time people thought we were on the verge of colonizing space. But then tight budgets cut the size of the STS fleet, and the cost of a pound sent into orbit remained in three figures. Visions of big O'Neill colonies and grand cities on the moon foundered without the bootstrap mass to build the dreams.

The lock passed me through. I stowed my hardsuit in a restorer locker whose nameplate simply read "Bossman." While I racked my equipment, I recalled all the times I had explained the Tank Farm to audiences on Earth: to congressmen, housewives, and investors—to anyone who would listen.

Back in the early '80s it was shown that the thirty-five-ton external tank can be carried all the way into orbit *at zero cost* to the orbiter's thirty-ton cargo capacity. Thirty-five tons of aluminum and polymers, already shaped into vacuum-tight cylinders, delivered free!

And that wasn't all. On arrival the tanks would contain another five to thirty-five tons of leftover liquid hydrogen and oxygen, usable in upper stage engines, or to run fuel cells, or to be converted to precious water.

At a time when the grand hopes for space seemed about to fall apart, the ET was like manna from Earth to Heaven. When the government didn't seem eager to seize the opportunity—when they built their cramped, delicate, little "space stations" from expensive modules in the old-fashioned way—the Colombo-Carroll Foundation, a consortium of U.S. and Italian interests, offered to buy the tanks.

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We would save them, until the world wised up and bought them back. Meanwhile, the Tank Farm would provide orbit boosts via the tether-sling effect, saving customers fuel and time and paying our way until our other investments matured.

For ten years the Farm had been on course, but it seems we'd neglected a few lines of fine print in our contract. The Feds had to let us buy the tanks at a fixed price, but nothing in the contract said they had to give us the residual hydrogren and oxygen, too.

It never occurred to us they'd not want to give us all the water we needed! Who in the world would have thought they'd ever want to take the Tank Farm away from us?

3.

Imagine six very long parallel wires, hanging in space, always aimed toward the surface of the Earth 500 kilometers below.

At both ends the wires are anchored to flat rows of giant cylinders—forty in the upper layer, Arnold Deck; and sixteen in the lower, Brown Deck. An elevator, consisting of two welded tanks, moves between the two ends, carrying men and supplies both ways.

I've lost count of the number of times I've explained the curious structure to visitors. I've compared it to a double-ended child's swing, or a bolo turning exactly once per orbit, so that one end is always low and the other always high. It's been called a Skyhook, and even a Beanstalk, though the idea's nowhere near as ambitious as the ground-to-geosynchronous space-elevators of science fiction fame.

The main purpose of the design is simply to keep the tanks from falling. The two massive ends of the Farm act like a dipole in the gradient of the Earth's gravitational field, so each deck winds up orbiting edge-forward, like a flat plate skimming. This reduces the drag caused by the upper fringes of the atmosphere, extending our orbital lifetime.

The scheme is simple, neat, and it works. Of course the arrangement doesn't prevent *all* orbital decay. It takes a little thrust from our aluminum engines, from time to time, to make up the difference.

Since our center of mass is moving in a circular orbit, the lower deck has to move much slower than it "should" to remain at its height. The tethers keep it suspended, as it were.

The upper deck, in turn, is dragged along *faster* than it would normally go, at its height. It would fly away into a high ellipse if the cables ever let go.

That's why we feel a small artificial gravity at each end, directed away from the center of mass. It creates the ponds in my garden, and helps prevent the body decay of pure weightlessness.

When I entered the darkened control chamber, I moved quietly behind the chief flight controller and watched. The controller's main screen showed the interdeck elevator stopped about three klicks above B Deck. The reason for its delay came into view in a few moments: a small delta-wing whose white tiles shone against the starfield. I stood in the shadows and listened as our operators conversed with the shuttle pilot.

"*Pacifica*, this is A for Arnold Deck control. You are cleared for orbit inter-

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section. In a minute we'll transfer you to B for Brown, for final approach. Extend your landing gear now."

"*Roger, Arnold Deck.* Pacifica, *ready for landing.*"

The orbiter drifted toward B Deck. On the controller's screen I could see *Pacifica*'s landing gear deploy in the deep black of space.

The inner face of B Deck was covered with a flat surface of aluminum plates, surrounded by a low fence of soft nylon mesh.

Pacifica was at the highest point of her elliptical orbit. Her velocity would, for a few minutes at apogee, be virtually the same as B Deck's, allowing a gentle approach and contact. (A few purists still refused to call the docking a "landing.") The shuttle gave off small puffs of reaction gas to align her approach.

It was a beautiful technique, and the unargued greatest asset of the Tank Farm. When *Pacifica* was secured to B Deck, she would be carried along in the Farm's unconventional circular orbit until it was time for her to go. Then *Pacifica* would simply be pushed over the edge of B Deck, to fall toward Earth again, finishing her original ellipse.

I looked at the screen showing the underbelly of B Deck. A great net of nylon hung below the plain of cylinders. Within, like a caterpillar trapped in a web, was *Pacifica*'s ET, the external tank that had powered her into orbit, sent ahead and snagged on a previous pass.

So the bad news boys had brought one of the magic eggs with them. I hoped it was a good omen, though it was probably just a coincidence of scheduling.

Until a year ago most of the orbiters visiting the Farm also delivered their external tanks, along with several tons of residual hydrogen and oxygen propellants in each. Then a new administration started reneging, stockpiling ETs at the Space Stations instead, and denying us our allotment. The Foundation took them to court, of course, and forced a delivery rate of at least ten ETs a year.

The new administration didn't like losing face. Now they'd found a way to get even. Our contract said they had to sell us the tanks, but it said nothing about the water.

"Um, Dr. Rutter, could I speak with you for a minute?"

I turned to see an earnest-looking, black-haired young woman. She clutched a roll of strip-charts. Emily Testa was a very promising new member of the Farm, sent up by the Italians, the junior partners in Colombo Station.

"This is really a bad time, Emily. Is it important?"

"Well sir . . ." She caught my warning look. "I mean *Ralph* . . . Since I arrived I have been studying the problem of electrical currents in the tether cables, and I think I have learned something interesting."

I nodded as I recalled the project I'd given the young newcomer to get her started. It was a nagging little problem that I'd wanted to have someone look into for some time.

The Kevlar tethers that held the Tank Farm together were sheathed in an aluminum skin to protect them from solar ultraviolet radiation. Unfortunately this meant there was an electrical conducting path from B Deck to A Deck. As the

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Farm swept around the Earth in its unconventional orbit, the cables cut through a changing flux from the planet's magnetic field. The resulting electrical potentials had caused some rather disconcerting side effects, especially as the Tank Farm had grown larger.

"Go on, Emily," I suggested. But I couldn't help listening with only half my attention. *Pacifica* was coming in, gear extended like a fighter landing on an aircraft carrier. I could hear the controllers talking softly in their singsong dialect.

"Well, sir," Emily said, almost without a trace of accent, "I wasn't able to find a way to prevent the potential buildup. I'm afraid the voltage is unavoidable as the conductive tethers pass through the Earth's magnetic field.

"In fact, if the charge had anywhere to go, we could see some pretty awesome currents. One deck might act as a cathode, emitting electrons into space, and the other could be an anode, absorbing them from the surrounding plasma. It all depends on whether . . ."

Pacifica touched down with barely a bump. Her landing gear flexed slightly as she rolled to a stop. The interdeck elevator resumed its descent as the orbiter was tied down by the B Deck crew. Her cargo was removed from the open cargo bay by giant manipulator arms.

Two spacesuited figures drifted down from *Pacifica*'s hatch and stood waiting for the elevator. It didn't take a lot of imagination to guess who they were. Our bad news boys.

Emily went on, single-mindedly, apparently unaware of my split attention. ". . . so we could, if we ever really wanted to, *use* this potential difference the tethers generate! We could shunt it through some transformers here on A Deck, and apply as much as twenty thousand volts! I calculate we might pull more power out of the Earth's magnetic field, just by orbiting through it with these long wires, than we would ever need to run lights, heat, utilities, and communications, even if we grew to ten times our present size!"

The boys in the spacesuits got into the elevator. The crew loaded *Pacifica*'s cargo after them, encased in blue DOD shrouding.

"Emily," I turned fully to the young woman. "You know there ain't no such thing as a free lunch. Your idea certainly is interesting. I'll grant you could probably draw current from the tethers, maybe even as much as you say. But we'd pay for it in ways we can't afford."

Emily stared for a moment, then she snapped her fingers. "Angular momentum! Of course! By drawing current we would couple with the Earth's magnetic field. We would slow down, and add some of our momentum to the planet's spin, microscopically. Our orbit would decay even faster than it already does!"

I nodded. "Right. Still, it's a good idea. If we were getting all the water we used to receive, so we could run the aluminum engines as before, we might even decide to draw power your way.

"But our solar cells are really more than adequate. We could sell our excess to Earth, if they could only agree on a way to receive it."

She looked a little crestfallen. "Keep at it, though," I said for her morale's sake. "Maybe there's a way to turn these electrical phenomena to our ad-

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vantage. We ought to have a break coming, about now." I tried to sound as if I believed it. Emily brightened a bit.

The elevator started rising, on its way up here to A Deck. I had about half an hour to get ready—to shave, and to shower away the aroma of my garden. It probably wouldn't do any good, but I'd want to look presentable to the bad news boys.

4.

We held the meeting in the lounge, in front of a crystal window. Susan Sorbanes, our business manager, took her place to my left, Don Ishido to my right. There were no chairs, but we stood at rest in the feeble gravity, a table made of spun aluminum fibers between us and the federal officials. Our backs were to the giant quartz window.

Across the table, Colonel Robert Bahnz, the new DOD representative, floated impassively. He had said hardly a word, apparently content to leave the talking to Herman Woke, the NASA official who had come up in *Pacifica* with him. Bahnz stood at a slight angle, which had to take a certain amount of work. Was it his way of showing his contempt for the Tank Farm's famous gravity, so unlike the freefall conditions in the government's shiny little Space Stations?

"So you people have decided to hit us on two fronts all at once, Dr. Woke?" Susan spoke softly, but her voice had a cutting edge. "You're going to attack the Farm's man-rating, and you're cutting back on our share of the residual propellants and water."

Woke was a middle-aged bureaucrat who must have convinced himself long ago that space visits were a route to advancement in NASA. I could tell by his faint green pallor that he was doped up against space sickness.

"Now, Dr. Sorbanes," he said. "Safety's been an issue ever since a crewman fell from B Deck two years ago. As a quasi-federal institution, Colombo Station must adhere to man-rating policy. That's all we are interested in."

"We've had a good safety record for ten years, except for that one incident," Susan replied. "And Congress gave us exemptions from NASA man-rating requirements back in '89, you'll remember."

"Yes, but those exemptions expire this year. And I think you'll find this Congress less willing to take chances with the safety of its citizens in orbit."

"I don't see why we have to go the gold-plated route NASA and DOD used in the Space Stations," Susan said acidly. "All that approach accomplished was to slow you down by a decade, and almost turn the country off on space for good!"

Woke shook his head. "Perhaps, Dr. Sorbanes. Indeed, it's because NASA has seen the value of the Tank Farm approach that we had last year's unfortunate misunderstanding regarding tank deliveries. Since Stations Two and Three began operating their own propellant recovery units and aluminum smelters, we've found that we need the leftover tanks as much as you do. We're all going to have to share. That's what it comes down to."

Don Ishido shook his head. "That's a load of bull! Our contract only guarantees us a third of the tanks launched, in return for which we use the slingshot

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effect to boost government and commercial cargoes into higher orbits, and provide shuttles like *Pacifica* with temporary angular momentum loans. That leaves you with two-thirds of the tanks to do with as you wish!

"Let's face it. It's not the tanks that are causing the problem. It's you stealing our water!"

I cleared my throat. It was time to step in, before this broke down completely.

"I think what Mr. Ishido means, Dr. Woke, is that Colombo Station depends on delivery of at least fifty tons of residual propellants a year, for life support, chemistry, and especially to provide oxydizer for our aluminum engines. Without those engines, our orbit will decay, and we'll be forced to use the extremely inefficient method of flinging away tanks to maintain altitude. The Farm will cease accumulating mass, and our value to our investors will disappear . . . this just as we were about to show a real profit for the first time."

Woke shrugged. "Of course we have no intention of cutting off the water and oxygen you need to maintain life support. No one even considered such a thing. . . ."

Damned right, I thought. Nothing would alienate the public like that. But trimming our ration, forcing us to spend tanks as fast as we get them—they could pull that off without trouble.

Yeah. We had almost closed a deal with some big Earthside chemical houses to produce large amounts of low-g biochemicals on B Deck, when NASA Station Two undercut us by $2 million. But the killer had really been the rumors over our water situation. The investors had shied away from the uncertainty.

It hurt like hell. We were just short of making it. We had gobs of solar power, but the Earthsiders couldn't agree on how to receive it. With water and our giant tanks we could run a tremendous chemical plant, but timid companies stopped just short of buying in. We'd planned to set up a space hotel and sell vacations for scores of tourists at a time, but we were stymied by this "man-rating" straw man.

Our ecological recycling system had us ninety-five percent independent of Earth resupply. Our smelter was operational and waiting for customers: We had developed the aluminum engine.

But all anyone wanted to buy was the slingshot effect. We were a glorified switching yard in orbit. And the new government clearly wanted us to stay just that.

Woke kept up his soothing apologia. I had heard it all before. I wasn't the one to fight him, anyway. That was up to our lawyers back in Washington. My job was to come up with miracles. And right now they appeared to be in short supply.

The crewcut DOD man, Bahnz, was staring at something over my shoulder. I shifted a little to look.

Out on A deck they were readying a Defense cargo for launch. They had peeled the blue shrouding and set the cylinder near the edge of the deck. At the right moment the package would slip off into the starry field below us, falling away from Earth in a steep ellipse. At apogee a motor would cut in, carrying

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the spysat the rest of the way to geosynchronous orbit.

Bahnz had a gleam in his eyes as he observed the preparations.

You want my Farm, don't you? I thought. You peepers fought us in the beginning, but now you see we're the one thing keeping us ahead of the other nations in space. Now you want my Tank Farm for your own.

Two years ago, they had tried to get us to store "strategic assets" in the A-Deck tanks. I threatened to resign, and the Foundation found the guts to refuse. That's when the troubles had started.

Bahnz noticed my look, and smiled a knowing smile.

He thinks he holds all the aces, I thought. *And he might be right.*

There were some old SF stories I read when I was a kid, about space colonies rebelling against Earth bureaucracies. I had a brief fantasy of leading my crew in a "tea party," and kicking these two jerks off of our *sovereign territory.*

Bahnz saw the peaceful smile on my face, and must have wondered what caused it.

Of course the rebellion idea was absurd. We might be ninety-five percent free of Earth logistical support, but that last few percent would be with us for a hundred years. Anyway, without either water or new tanks every year, Mother Earth's atmosphere would quickly pull us down.

While Don and Susan kept up our side of the charade, I looked out the window, thinking.

Next year would be a solar maximum, when the coronal ion wind would come sleeting in. The upper atmosphere would heat up and bloat outward, like a high tide dragging at our knees. At solar max we could lose twenty kilometers in a single year. Maybe much more.

Our investors would be caving in within eighteen months. Even the Italians would soon be begging the U.S. administration to make a deal.

For an instant I saw the Earth not as a broad vague mass overhead, but as a spinning globe of rock, rushing air, and water, of molten core and invisible fields, reaching out to grapple with the tides that filled space. It was eerie. I could almost *feel* the Tank Farm, like a double-ended kite, coursing through those invisible fields, its tethers cutting the lines of force—like the slowly turning bushings of a dynamo.

That was what young Emily Testa had compared it to. A dynamo. We could draw power from our motion if we ever had to—buying electricity, and paying for it in orbital momentum. It was a solution in search of a problem, for we already had all the power we needed.

The image wouldn't leave my mind, though. I could almost *see* the double-ended kite, right there in front of me . . . a dynamo. We didn't *need* a dynamo. What we needed was the opposite. What we needed was . . .

"I think we should recess," I said suddenly, interrupting Dr. Woke in the middle of a sentence. It didn't matter. My job wasn't diplomacy. It was miracle-working.

"Susan, would you show our guests to some rooms? We'll all meet again over supper in my cabin, if that's okay with you gentlemen?"

Woke nodded resignedly. I think he had hoped to go back down right away

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in *Pacifica*. Colonel Bahnz smiled. "Dr. Rutter, will you be serving Slingshot with dinner?"

"It's traditional," I replied, anxious to get rid of the man.

"Good. It's one of the reasons I came up today." Bahnz's grin seemed friendly enough, but there was an undertone to his voice that I understood only too well.

I waited until they had left, then turned to Ishido. "Don, go fetch Emily Testa and meet me in the power room in five minutes."

"Sure, chief. But what . . ."

"There's something I want to try. Now shake a leg!"

I kicked off down the hallway, looking for a computer terminal. I don't think I touched the floor twice in fifty yards.

5.

For all of our Spartan lifestyle, there are a few places the crew has tried to make "posh." One is the main lounge. Another is the "Captain's Cabin." My quarters were given that name when the Foundation first had the idea of setting up a tourist hotel. They figured making a big deal out of dinner in my quarters would give a visit more of the flavor of a Caribbean cruise.

The aluminum walls had been anodized different pastel shades. The gold carpet had been woven from converted tank insulator material. And in wall niches were a dozen vacuum-spun, aluminum wire sculptures by Dave Crisuellini, our smelter chief and resident artist.

The Captain's Table was made of oak, brought up at six hundred dollars a pound for one purpose only: to look impressive.

Herman Woke sat to my right as the volunteer stewards served us from steaming casserole dishes. Next to Woke sat Susan Sorbanes. Across from them were Emily Testa, nervously fingering her fork as her eyes darted about the room, and Ishido. Colonel Bahnz sat across from me.

Woke looked considerably less green around the gills. His eyes widened at the soufflé in front of him. "I'm impressed! I'd heard that a hundredth of a gee is enough to enable the inner ear to come to equilibrium, but I hadn't believed. Now, to be able to eat from plates! With forks!" He spoke around a hot mouthful. "This is delicious! What is it?"

"Well, most of our food is prepared from termite flour and caked algae . . ."

Woke paused chewing. Susan and Ishido shared a look and a smile.

". . . however," I went on, "recently we have begun raising our own wheat, and chickens for eggs."

Woke looked uncomfortable for another moment, then apparently decided to accept the ambiguity. "Ingenious," he said, and resumed eating.

"We have a number of ingenious people here," Susan said. "Many of our crew served aboard the Space Stations, and came here when NASA went through cutbacks and furloughed them.

"Others were hired by the Foundation because of their varied talents. Emily here," she smiled at young Testa, "is a fine example of the sort of colonist we're looking for."

Emily blushed and looked down at her plate. She was very tired after the

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last few hours, as we furiously experimented with the Farm's power system.

Colonel Bahnz squeezed an aluminum-foil beer bottle, his second. "You're right about one thing, Dr. Sorbanes," the DOD man said. "The U.S. Government has subsidized this venture in many hidden ways. Most of your personnel got their training at taxpayer expense."

"Have we ever failed in our gratitude, Colonel?" Susan spoke with pure sincerity. And to Ishido and I, the answer was obviously no. We tankers think of ourselves as custodians of a trust.

But Bahnz clearly disagreed. "Do you call it *gratitude*, using lawyers' tricks to put restrictions on your country's use of valuable resources at the very moment when she needs them most?"

"We believe," Susan said, "that need will be greatest in the future. And we plan to be here, with the key to a treasure chest, when the time comes."

"Dreams of glory," Bahnz sneered. "I know all about them. Tell me about lunar mines and space colonies and other fairy tales, Dr. Sorbanes. And I'll tell you about Low Earth Orbit, now filled with garbage and bombs and little cameras from half a hundred bickering, hungry little nuclear powers, all blaming each other for a world economy in a thirty-year skid!

"Have you any idea what would happen if even *one* of these arrogant little 'spacefaring nations' decided to ignite a small enhanced radiation device in that cloud of communications satellites overhead? You know as well as I how dependent we are on orbital datalinks. And you know the only way to defend those links is to put our satellites inside big Faraday cages."

Bahnz struck the nearby aluminum wall. "*This* is what your country needs, Dr. Sorbanes. This tank and others like it! And the propellants for upper-stage launches. And we need this *station*, for the momentum transfer you now almost *give* away to anyone who wants it!"

Susan was gearing up for a major rebuttal. I hurried to interrupt. "People, please! Let's try to relax, if only for a little while. Colonel Bahnz, you seem to like Slingshot. That's your third bottle."

Bahnz had plucked another bottle from a passing steward. "Why not," he shrugged. "It costs a hundred bucks a pint on Earth. It's damn fine beer."

"Dr. Ishido is our brewmaster."

Bahnz lifted the bottle to Don and bowed his head in silent tribute. An aficionado of beer need say no more; Ishido nodded at the colonel's compliment.

"Director Rutter," Bahnz turned to me, "Dr. Woke and I will be leaving within two hours. I have held *Pacifica* for several orbits to please you. But our business here is done. If you have anything more to say, you can speak through your Foundation's Washington office."

Bahnz was obviously the type that got straight to the point, especially when he had had a bit to drink. He showed no trace of that irreverent streak I had known in the officers and officials of the early '90s. Those fellows had been almost like co-conspirators, helping nurture the Farm along in a time of tight budgets and dubious senators.

"Two hours, Colonel? Yes. That

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should be enough time. Just remind *Pacifica*'s crew to check their inertial tracking units before drop-off. There may be a few acceleration anomalies."

Bahnz snorted. "So? You plan to fire up your famous aluminum engines to impress us? Big deal. Go ahead and use up your reserve water, Rutter. You've got oxidizer to run them for maybe two months; then you'll have to start flinging mass away to keep orbit."

Ishido started to rise. At a sharp look from me he subsided.

"Why Colonel," I said smoothly. "You sound downright happy over our predicament."

The crewcut officer slapped the oak table. "Damned straight! Let's lay it out, Rutter. I think you're a bunch of unpatriotic dreamers who'd do anything other than serve your country. July's court judgment was the last straw.

"We're going to live up to the contract, all right. You'll get your tanks, and enough water to keep from making martyrs of you. But you'll start spending more mass to stay in orbit than you take in. Your profits will disappear. Then see how fast your investors force you out as director!

"Pretty soon, Rutter, *you'll* be buying Slingshot at a hundred clams!" Bahnz emptied the squeeze-bottle with a flourish.

I shrugged and turned back to my meal. The second worst thing you could do to a man like Bahnz was to ignore him. I intended to do the very worst thing within an hour and a half.

6.

The face on the screen was flushed and angry. In the dimness of Arnold Deck Control Room, I could tell the man was upset.

"What the *hell* do you think you're doing, Rutter?"

I had made *Pacifica* wait for fifteen minutes while the control crew made a show of looking for me, then appeared, to look back at him with an expression of beatific innocence.

"What seems to be the problem, Colonel?"

"You know damned well what the problem is!" The man shouted. "Colombo Station is under acceleration!"

"So? I told you over dinner to have your crew check their inertial units. You knew that meant we would be maneuvering."

"But you're thrusting at two *micro-gees!* Your aluminum engines can't push five thousand tons that hard!"

I shrugged.

"And anyway, we can't find your thrust exhaust! We look for a rocket trail, and find nothing but a slight, isotropic electron cloud spreading from A Deck!"

"Nu?" I shrugged again. "Colonel, you force me to conclude that we are not using our aluminum engines. It *is* curious, no?"

Bahnz looked as if he wanted some nails to chew—three-penny, at least. Behind him I could see the crew of *Pacifica*, crouched over their instruments in order to stay out of his eye.

"Rutter, I don't know what you're up to, but we can see from here that your entire solar cell array has been turned sunward. You have no use for that kind of power! Are you going to tell me what's going on? Or do I come

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back up there and make myself insufferable until you do?''

My respect for Bahnz rose two notches. He might be an SOB, but he knew how to get his way. ''Oh there won't be any need for that,'' I laughed.

''You see, Colonel, we need all that solar power to drive our new motor.''

''Motor? *What* motor?''

''The motor that's enabling us to raise our orbit without spending a bit of mass—no oxygen, not even a shred of aluminum. It's the motor that's going to make it possible for us to pull a profit next year, Colonel, even under the terms of the present contract.''

Bahnz stared at me. ''A *motor?*''

''The biggest motor there is, my dear fellow. It's called the Earth.''

He blinked, his mind obviously whirling to figure out what I meant.

''Have a good trip, Colonel,'' I said. ''And any time you're in the neighborhood, do stop by for a Slingshot!''

''Rutter!''

I turned away and launched myself toward the window at the far end of the control room.

''RUTTER!''

The voice faded behind me as I drifted up to the crystal port. Outside, the big, ugly tanks lay like roc eggs in a row, waiting to be hatched. I could almost envision it. They'd someday transform themselves into great birds of space. And our grandchildren would ride their offspring to the stars.

Three bright, silvery cables seemed to stretch all the way to the huge blue globe overhead. And I knew, now, that they did indeed anchor us to the Earth . . . an Earth which does not end at a surface of mountain and plain and water, nor with the ocean of air, but continues outward in strong fingers of force, caressing her children still.

Right now those tethers were carrying over a hundred amps of current from B Deck to A. There, electrons were sprayed out into space by an array of small, sharp cathodes.

We could have used the forward process to extract energy from our orbital momentum. I had told Emily Testa earlier today that that would solve nothing. Our problem was to *increase* our momentum.

Current in a wire, passing through a magnetic field . . . You could run a dynamo that way, or a *motor*. With more solar power than we'll ever need, we can shove the current through the cables *against* the electromotive force, feeding energy *to* the Earth, and to our orbit.

A solar-powered motor, turning once per orbit, our Tank Farm rises without shedding an ounce of precious mass. I smiled as I looked out on the fleecy clouds of home and the tanks in a row, like presents, waiting to be opened.

I felt Susan come up beside me. ''*Pacifica*'s gone,'' she said. ''And our acceleration's climbed to three microgees, Ralph.''

I nodded. ''Have Don ease back a bit for now. We don't want to push the motor too hard on its first day. I'll check in later.''

''Where are you going?''

I caught a rung by the hatch. ''I'm going to go unwind by spending some time puttering in my garden.''

Susan shook her head and muttered ''Yuck'' under her breath.

I pretended I didn't hear her. ■

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Jay Kay Klein's biolog

If the *Analog* contributors profiled here sound interesting, it's because they are. David Brin is one of the "hard science" writers who—along with their counterweights, the "social engineers"—have formed the cutting edge of modern science fiction in this magazine. When intense demands on his time while pursuing a rigorous undergraduate degree at Caltech in Astronomy caused Dave to suspend all science fiction reading, he found himself writing it instead. *Sundiver*, a first novel and first submission, turned into a first sale. It was published by Bantam in 1980, the same year Dave received a Ph.D. in Applied Physics and Space Science from UC San Diego.

Photo by Raymond E. Feist

David Brin

Dave worked as an engineer for four years at Hughes Aircraft and remains a consultant for the California Space Institute, studying variations on space station design and shuttle enhancements. Another slice of his time is devoted to lecturing at San Diego State University. Writing remains a part-time occupation, evidenced by his having turned out "only" three novels so far. A second story submission, "The Tides of Kithrup," appeared as a cover-story novelette in the May 25, 1981, *Analog*. In greatly expanded form, it will be published about the time you're reading this by Bantam as *Startide Rising*. And early next year, Bantam will be bringing out *The Practice Effect*.

Now that he has a little more time—even with some of it spent backpacking in the Great West—Dave thinks he will be able to write more science fiction. Last year he was a nominee at the world science fiction convention for the John W. Campbell Award for Best Writer. At this year's convention "The Postman," which appeared in *Analog*'s sister publication, *Isaac Asimov's Science Fiction Magazine*, was a nominee for a Hugo Award.

To Dave, "science" is a major character in a well-wrought story, though not necessarily the most important item where human beings are involved. He views science fiction as humanity's think tank in a time of rapid change. His hope is that science fiction will be read by people who otherwise would not know much about science or think ahead to what can happen. And in particular, there may be political or business leaders who, faced with a crisis, might think about some similar problem they'd encountered in a story. If in that way some typical dumb "solution" of the type we've seen far too often in the past can be avoided in the future, then Dave feels time spent on science fiction will have paid for itself a thousand times over. ■

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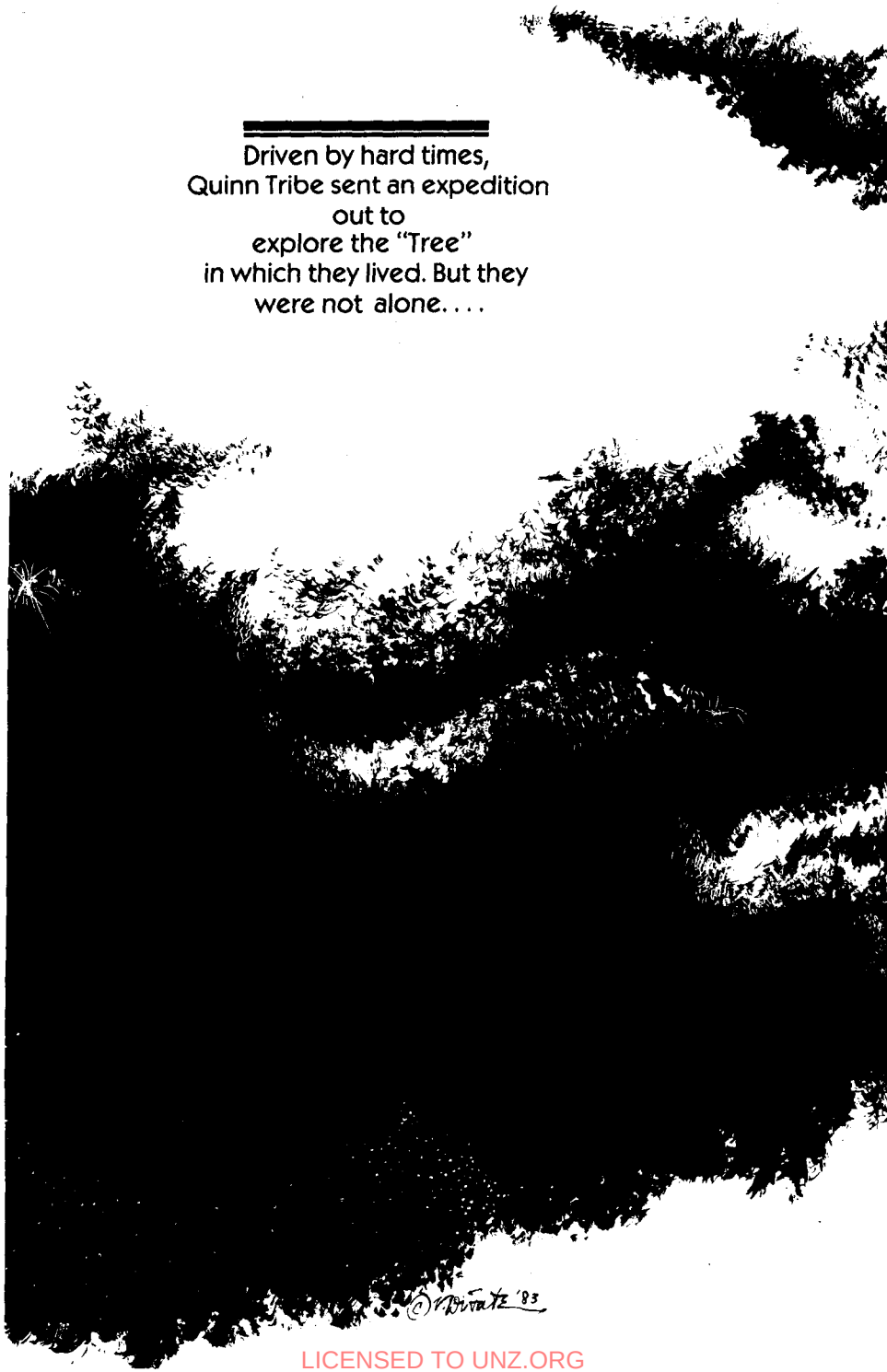

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Vincent Di Fate

Part Two of Four

Larry Niven

THE INTEGRAL TREES

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SYNOPSIS

Levoy's Star—"Voy"—is the ashes of an ancient supernova, a cold neutron star of half a solar mass.

A gas giant planet circles Voy at four times the Earth's radius. Goldblatt's World—"Gold"—orbits within, and continually leaks its atmosphere into, a gas torus surrounding the neutron star.

The thickest part of the gas torus has the appearance of a green-tinged smoke ring: clouded by water droplets, and green with life that has been evolving in free fall for a billion years. The Smoke Ring is illuminated by a G-type companion star, and includes rock and water and soil lost from Goldblatt's World during its first catastrophic approach to Levoy's Star. Its volume—the foggy region where the air becomes thick enough to breathe—is around thirty times that of the Earth.

Five hundred years ago men entered the ecology, via the interstellar ramship Discipline.

Sharls Davis Kendy *(once a Checker for the State on Earth, now a computer program for* Discipline*) remembers little of what must have been a mutiny. He knows only that he abandoned his crew to their fate within the Smoke Ring. He has been waiting in the L2 point outside Goldblatt's World for more than five hundred years.*

Surely the tools and knowledge the mutineers took with them will eventually help them to rebuild within the free-fall environment. Once they have something like a civilization, Kendy can help them rebuild the State. But he has seen no evidence of progress.

And so he waits. . . .

From the cassettes of Quinn Tuft, now carried by the **Grad:**

PLANTS

Life pervades the Smoke Ring, but is neither dense nor massive. In the free fall environment, plants can spread their greenery widely to catch maximum sunlight and passing water and soil, without bothering about structural strength. We find at least one exception. . . .

These integral trees grow to tremendous size. The plant forms a long trunk under terrific tension, tufted with green at both ends, stabilized by Levoy's Star's ferocious tide. They form thousands of radial spokes circling Levoy's Star. They grow up to a hundred kilometers in length, with up to a fifth of a gee in tidal "gravity" at the tufts, and perpetual hurricane winds.

The winds derive from simple orbital mechanics. They blow from the west at the inner tuft, and from the east at the outer tuft (where *in* is toward Levoy's Star, as usual, and *west* is the Smoke Ring's direction of rotation). The structure bows to the winds, curving into a nearly horizontal branch at each end. The foliage sifts fertilizer from the wind. . . .

The medical dangers of life in free fall are well known. If Discipline has indeed abandoned us, if we are indeed marooned within this weird environment, we could do worse than to settle the tufts of the integral trees. . . .

Quinn Tuft is going through drought and famine. The **Scientist** *attributes this to the tree's close approach past Gold some years ago. The tree has dropped too close to Voy, too far out of the Smoke*

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Ring. Water and air and soil all have become too rare.

Whatever the reason, something must be done. The **Chairman** *has sent a hunting party up the trunk. At worst they can repair the tribal markings cut into the bark. They may find something to help: a food source, a way to move more water down, anything to feed Quinn Tribe.*

The Chairman seems to have chosen citizens whose disappearance he would not regret. The hunting party consists of:

Gavving, *a young warrior subject to allergies. He was present at the death of the Chairman's son.*

The Grad, *the Scientist's half-trained apprentice. The Scientist had his own reasons for wanting the Grad on the trunk.*

Clave, *a mighty hunter, and the leader. He may be here because he abandoned his wife, the Chairman's daughter.*

Jayan *and* **Jinny**, *twin sisters enamoured of Clave.*

Merril, *an older woman, strong but barren. Small, withered legs.*

Jiovan, *a crippled hunter.*

Glory, *a woman famed for clumsiness.*

Alfin, *an older man, Keeper of the treemouth. Alfin suffers from what, on Earth, would be mild acrophobia.*

The climb has been an arduous one. Quinn Tuft is the inner end of a huge tree, 100 kilometers long. Nonetheless, the tide—never more than a fifth of a gravity—dwindles as they climb. They have *found food sources. They have agreed to continue climbing, at least as far as the free fall region at the tree's median.*

The records tell that another tribe occupies the far tuft of the tree. . . .

CHAPTER 6: MIDDLE GROUND

The patch of old-man's-hair should have been tended to long since. It was fifty to sixty meters across, and had eaten half a meter deep into live wood. Parasol plants had rooted in the resulting compost, and matured, and spread their brightly colored blossoms to attract passing insects.

Minya watched the fire spread in intersecting curves within the fungus patch. Breezes tossed the choking smoke in unpredictable directions. The smoke drove clouds of mites out of the fungus and into the open. She was wishing Thanya's triad would arrive with water.

There were three triads of the Triune Squad now on the trunk. Minya, Sal, and Smitta were nearing the median. Jeel's triad traversed up and down the trunk, ferrying provisions from the tuft, while Thanya's brought water from the lee.

Fire was usually no problem, but mistakes could happen.

"I love these climbs," Smitta said. She floated with her toes gripping an edge of bark. This close to the median, it was enough to hold her against the feeble tide. "I like floating . . . and where else can you see the *entire* Smoke Ring?"

Minya nodded. She didn't want to talk. When a problem couldn't be solved and wouldn't go away, what could one do but run? She had run as far as a

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human being could go. It was working: she felt at peace here, halfway between infinities.

The tree seemed to run forever in both directions. The Dark Tuft, backlit by Voy and the sun, was a halo of green fluff with a black core. Outward, Dalton-Quinn Tuft was barely larger. A few drifting clouds, wisps of green forest, whorls of storm were all outward. Eastward was a point of bright light off-center in a dark rim: the same small pond that had been drifting tantalizingly closer for a score of days.

Maybe, maybe it would come. They didn't talk about it. Bad luck.

Between the drought and the recent political upsets, it had been too long since the Triune Squad was free for tree-tending duty. They had been needed as police. One could hope that the executions had settled the troubles, but now the triads were finding parasites and patches of old-man's-hair everywhere on the trunk. Today they were burning virtually a *field* of the horrid stuff.

Motion caught Minya's eye, outward and windward. Blue-against-blue, hard to see, something big. The sun was nearly at nadir, glaring up. She held a hand beneath her eyes, and squinted, and presently said, "Triune."

Smitta snapped alert. "Interested in us? *Sal!*"

Sal sang out from behind the smoke cloud. "I see it."

Minya said, "They're interested. They're pretty close already."

Smitta had pulled herself against the trunk and was readying her weapons. "I fought a triune once. They're smarter than swordbirds. You can scare them off. Just remember, if we kill one, we'll have to kill all three."

The torpedo-shaped object was closer now. It was nearly the blue of the sky, slowly rotating. Six big eyes showed in turn around the circumference, and three great gauzy fins . . . one smaller than the other. That would be the juvenile. Minya whispered, "What do we need?"

"Bows and arrows ready? Tether your arrow and scoop up some burning old-man's-hair on the point. Lucky we had a fire going. Know where your jet pods are, you may need them."

Minya could feel her heart pulsing in her throat. It was her second trip up the trunk . . . but Smitta and Sal had been up many times. They were tough and experienced. Sal was a burly, red-haired forty-year-old who had joined the Triune Squad at age twelve. Smitta had been born a man; she was a woman by courtesy.

Stay clear of Smitta, Minya told herself. Smitta was slow to anger, but under pressure something could snap in her mind. Then Smitta fought like a berserker, even among her own, and the only way to stop her was to pile on her.

Minya strung her hardwood bow and used an arrow point to dig out a gob of burning fungus. Ready—?

The torpedo split in three. Three slender torpedoes flapped lazily toward them, showing small lateral fins and violent-orange bellies. A male and a female, forever mated, plus a single juvenile who would put on body mass fast, then mature more slowly. They divided only to hunt or fight. The Triune Squad itself was named for the triune family's interdependence.

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The juvenile would be the smallest, the one hanging back a little. Two adults swept forward.

"Aim for the male," Smitta said, and loosed, the line trailing out behind the arrow. Which was male? Minya waited a moment to judge Smitta's target, then loosed her own weapon. She judged that they weren't in range yet . . . and she was right; the male's body rippled him free of the arrows' paths, while the female bored in. Sal had held back. Now she loosed, and the veering female caught an arrow in her fin.

She bellowed. She flapped once, and the arrow snapped free. Sal appeared from the smoke, yanked into the sky. It didn't seem to bother her as she reeled in, her ancient metal bow slung safe over her shoulder. The smouldering old-man's-hair had been left on the female's tail, and she was flapping madly.

Smitta sent a tethered arrow winging at the juvenile.

Both adults screamed. The female tried to block the arrow. Too slow. The juvenile didn't seem to see the arrow coming. Smitta yanked at the line and stopped it a meter short.

The female gaped.

The women were reeling frantically, but it wasn't necessary. The adults moved in alongside the infant, infinitely graceful. Small hands reached out from their orange bellies to pull them together. They moved away like a single blurred blue ghost against the blue sky.

"See? They're smart. You can reason with them," Smitta said.

Sal pulled a teardrop-shaped jet pod from one of the cluster of pockets that ran down and across the front of her tunic. She twisted the tip. A cloud of seeds and mist spurted away from her, thrusting Sal back toward the bark.

She coiled line and stowed her weapons, including the valuable bow. Springy metal, it was, handed down from old to young within the Triune Squad for at least two hundred years. "Well done, troops, but I think the fire is getting to the wood. I wish Thanya would get here. She couldn't have missed us, could she?"

To Minya's eye, the fire might have reached wood by now, or not. Hard to tell where old-man's-hair shaded over into rotted wood. "It's not bad yet," she said.

"I hate to waste jet pods, but . . . treefodder. I want to look for them," Sal decided. She gathered her legs under her, hands gripping the bark to brace herself, and jumped. She waved her arms to flip herself around until she could see the trunk. They watched her drift along the trunk, out toward Dalton-Quinn Tuft.

"She worries too much," Smitta said.

Seventy days had passed since Clave's citizens departed Quinn Tuft.

The tree fed myriad parasites, and the parasites fed Clave's team. They had killed another nose-arm, easily, chopping through its nose, then jabbing harpoons into its den. There were patches of fan fungus everywhere. Merril had slept a full eight days after eating from the red fringe of a fan fungus. The subsequent throbbing headache didn't seem to affect her climbing, and presently it went away. So the fan fungus served them as food, and they had found more

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of the shelled burrowers, and other edibles. . . .

The Grad saw it all as evidence of the tree's decline.

They had found a jet pod bush, like a mass of bubbles on the bark. Clave had packed a dozen ripe pods in a pouch of scraped nose-arm hide.

They had taken to camping just outside the water-washed wood. Clave laughed and admitted that they should have been doing that all along. They'd slept three times more on the tree: last night in a nose-arm's den, twice before in deep wounds in the wood, cracks overgrown with "fuzz" that had to be burned out first. The char had turned their clothing black.

They had learned not to try to boil water. The bubbles just foamed it out in a hot, expanding mass.

Tidal gravity continued to decrease until they were almost floating up the trunk. Merril loved it. Recovering from the fan fungus hadn't changed that. You *couldn't* fall; you'd just yell for help, and someone would presently throw you a line. Glory loved it too, and Alfin smiled sometimes.

But there were penalties. Now water had grown scarce, too. There was no wind this high, and thus no leeward stream of water. Sometimes you found wet wood, wet enough to lick dry. There was water in fan fungus flesh.

Here was the **DQ** mark Jinny had found. Good: it looked nearly clean. And half a klomter farther up the trunk, a fan-shape showed like a white hand against the sky. It must be huge. The Grad pointed. "Dinner?"

Clave said, "We'll find smaller ones around it."

"But wouldn't it look grand," Merril asked, "coming into the Commons?"

The Grad was pulling himself toward the tribal mark when Clave said, "Hold it."

"What?"

"This mark isn't overgrown like the others were. Grad, doesn't it look funny to you? *Tended?*"

"There's some fuzz growing, but maybe not enough." Then the Grad was close enough to see the *real* discrepancy. "There's no takeout mark. Citizens, this isn't Quinn territory."

Gavving and Jiovan had been left behind to tend the smokefire.

Hard-learned lessons showed here. Bark torn from the rim of a patch of fuzz served as fuel. Healthy bark resisted fire. A circle of coals surrounded the meat, all open to the fitful breezes. A sheltered fire wouldn't burn. The smoke wouldn't rise; it would stay to smother the fire. Even here in the open, the smoke hovered in a squirming cloud. The heat of burning stayed in the smoke, so the fire didn't need to be large. Gavving and Jiovan stayed well back. A shift in the breeze could smother an incautious citizen.

The meat should be rotated soon. It was Gavving's turn, but it didn't have to be done instantly.

"Jiovan?"

"What?"

Even Gavving wouldn't ask Jiovan how he lost his leg, nobody would; but one thing about that tale had bothered him for years. And he asked.

"Why were you hunting alone, that day? Nobody hunts alone."

"I did."

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"Okay." Topic closed. Gavving drew his harpoon. He pulled air into his lungs, then lunged into the smoke. Half blind, he reached over the coals with the harpoon butt to turn the nosearm legs, one, two, three. He yanked hard on his line to pull himself into open air. Smoke came with him, and he took an instant to fan it away before he drew breath.

Jiovan was looking in, past the small green tuft that had once enclosed his life, into the bluish-white spark that was Voy. His head came up, and Gavving faced a murderous glare. "This *isn't* something I'd want told around."

Gavving waited.

"All right. I've got . . . I had a real gift for sarcasm, they tell me. When I was leading a hunt . . . well, the boys were there to learn, of course, and I was there to teach. If someone made a mistake, I left him in no doubt."

Gavving nodded.

"Pretty soon they were giving me nothing but the fumblers. I couldn't stand it, so I started hunting alone."

"I shouldn't have asked. It used to bother me."

"Forget it."

Gavving was trying to forget something else entirely. This last sleep period he had wakened to find three citizens missing. He'd followed a sound . . . and watched Clave and Jayan and Jinny moor lines to the bark, and leap outward, and make babies while they drifted.

What lived in his head now was lust and envy balanced by fear of Clave's wrath or Jinny's scorn (for he had fixed on Jinny as marginally lovelier). He might as well dream. Any serious potential mate was back in Quinn Tuft, and Gavving couldn't offer anyway; he hadn't the wealth or the years.

That would change, of course. He would return (of course) as a hero (of course!). As for the Chairman's wrath . . . he hadn't been able to send Harp. Possibly Clave could have resisted him too. If they could end the famine, the Chairman could do nothing; they would be heroes.

Gavving could have his choice of mates—

"So I was hunting alone," Jiovan said, "the day Glory busted open the turkey pen."

For an instant Gavving couldn't imagine what Jiovan was talking about. Then he smiled. "Harp's told that tale."

"I've heard him. I was down under the branch that day, with one line to tether me and another loose, nibbling a little foliage with my head sticking down into the sky, you know, just waiting. It was full night at the New Year's occlusion. The sun was a wide bright patch shining up at me, and Voy drifting right across the center.

"Here came a turkey, flapping against the wind, still moving pretty fast, and backward. I put a net on my free line, quick, and threw it. The turkey's caught. Here comes another one. I've got more nets, and in two breaths I've got a turkey on each end. But here come two more, then four, and they're coming from above, and by now I can guess they're ours. I throw the end of the line I'm moored to, and I get a third turkey—"

"Good throwing," Gavving said.

"Oh, sure, there wasn't *anything* wrong with my throwing that day. But the sky was full of turkeys, and most

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GLOSSARY

BLUE GHOST and **GHOST CHILD** are aurora-like glow patches produced by magnetic effects above Levoy's Star's poles. Rarely visible.

BRANCH—One at each end of an integral tree, curving to leeward.

BRANCHLETS—Grow from the spine branches and sprout into foliage.

CARM—Cargo And Repair Module. *Discipline* originally carried ten of these.

COTTON-CANDY JUNGLES or **JUNGLES** describes almost any large cluster of plants. A good many plants and clusters of plants look like fluffy green cotton candy. Many are edible.

COPSIK—Slave. Used as a general insult.

COPSIK-RUNNER—Slavetaker or slavemaster.

DUMBO—A predator of the integral trees.

DAY—One orbit about Levoy's Star, the neutron star. (Equals two hours for Dalton-Quinn tree.)

FAN FUNGUS—An integral tree parasite. Parts are edible.

"FEED THE TREE"—Defecate, or move garbage, or die.

FLASHER—An insectivorous bird.

GHOST CHILD—See Blue Ghost.

GO FOR GOLD—Rush headlong into disaster. Or battle!

GOLD—See *Goldblatt's World*. Secondary meaning: something to avoid.

of them were going to get away, and I *still* thought it was kind of hilarious."

"Yeah."

"That's why I never told this story before."

Gavving suddenly guessed what was coming. "I can live with it if you don't want to finish."

"No, that's okay. It *was* funny," Jiovan said seriously. "But the sky was full of turkeys, and a triune family came to do something about all that meat on the wing. They split up and went after the loose turkeys. There wasn't a thing I could do but pull in my three."

Jiovan certainly wasn't smiling now. "The male went after one of my turkeys. Swallowed it whole and tried to swim away. It got the wrong line . . . picture one end of a line spiked deep in the branch, and that *massive* beast pulling on the other, and me in a loop in the middle. I suddenly saw what was happening, and I pulled the loop open and tried to jump out, and the loop snicked shut and my leg was ripped almost off and I was falling into the sky."

"*Treefodder.*"

"I thought I was treefodder, all right. Remember I still had a line in my hands? But with a turkey on each end, flapping like crazy, and I was *falling*. I tried throwing a turkey, I really did, I thought it might get caught in the branchlets, but it didn't.

"Meanwhile the triune male's been caught by something and it doesn't know what. It pulls back against the line and feels a tug in its belly and throws up. I think that's what must have happened. All I know is something smacks me in the face, and it's a dead turkey covered with goo, and I grab it—I hug

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it to me with all my heart and climb the line back into the tuft."

Gavving was afraid to laugh.

"Then I tie off what's left of my leg. What's hanging loose, I had to cut off. Well, kid, did Harp ever tell you a story like that?"

"No. Treefodder, he'd *love* it! Oh."

"He'd make me famous. I don't want to be famous that way."

Gavving chewed it over. "Why tell me now?"

"I don't know. My turn," Jiovan said suddenly. He filled his lungs and disappeared into the smoke.

Gavving felt burdened. Always he asked too many questions. He grinned guiltily, picturing Jiovan trying to throw a line with a turkey flapping at each end. But what if Jiovan regretted telling it?

He saw Clave appear from behind the curve of the trunk.

Jiovan emerged, bringing smoke, and Gavving held his breath while it cleared. Jiovan coughed a little. "It's been so long," he said. "Maybe it doesn't hurt as much. Maybe I just wanted to tell it. Maybe I had to."

"They're coming back," Gavving said. "I wonder what's got them so excited?"

Clave bellowed, "I will not go home without learning something about them!"

"I know quite a lot about them," the Grad answered. "We all lived in the far tuft once. The Quinns left after some kind of disagreement. Before that, it was Dalton-Quinn tribe."

"Then they're relatives."

The argument had grown a little less chaotic, but only because half the troop was trailing back. It was no less vehement. Alfin shouted, "You're not listening. They kicked us out! For all we know, they think they're still at war with us!"

The Grad said, "Clave, the tribemarks are tended, and we aren't finding as many fan fungus lately, or the shelled things either. I'm thinking they keep this stretch of trunk clean. They must be still around. Our move is to get out of here!"

"You want to run from something you haven't even seen!"

"We saw the tribal insignia," the Grad said. " '**DQ**.' No take-out mark across the '**Q**.' Maybe they still call themselves Dalton-Quinn. What does that make us? Intruders on *their* tree? We've passed the median anyway, we're in their space. Clave, let's go home. Kill another nosearm, pick some fan fungus and one of the shells, and go home with plenty of food." Clave was shaking his head. "The tribe won't have to go thirsty any more either! We bring water from the trunk—"

Clave waved it away. "That water would get to the tuft anyway. No. I want to meet the Daltons. It's been hundreds of years, we don't know *what* they're like . . . maybe they know better tending methods for the earthlife, or ways to get water. Maybe they grow food we never heard of. *Something*. 'Day, Jiovan."

" 'Day. What's going on?"

"We found a tribemark and it isn't ours. The question before the citizenry is, do we say hello before going home? Or do we just run?"

The Grad jumped in. "Don't you see, we can't fight and we can't negotiate! We've got one good fighter, and two cripples and a boy and four women and

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GOLDBLATT'S WORLD—A gas giant planet captured after Levoy's Star went supernova/neutron. Named for *Discipline*'s astrophysicist, Sam Goldblatt.

HUTS—Any dwelling. In the integral trees, huts are woven from living spine branches.

INTEGRAL TREES—A crucial plant.

JET POD—Some plants grow pods that may be carried for attitude control: they jet gasses (of corruption, or of oxygen in plants that favor the outer fringes of the Smoke Ring.) Other plants fire seeds when dying, or going to seed, or falling too far out of the Smoke Ring. There are tropisms.

LEVOY'S STAR—A neutron star, the heart of the Smoke Ring system. Named for its discoverer, Sharon Levoy, astrogator assigned to *Discipline*.

NOSE-ARM—See **DUMBO.**

OLD-MAN'S-HAIR—A fungus parasite on integral trees.

POND—Any large globule of water.

PRIKAZYVAT—Originally, Russian for "command." Presently used to activate computer programs.

QUINN TUFT—The in tuft (or point nearest Levoy's Star) of Dalton-Quinn Tree.

SPINE BRANCHES—Grow from the branch of an integral tree.

SUN—A G0 star orbits the neutron star at 2.5×10^8 kilometers, supplying the sunlight that feeds the Smoke Ring's water/oxygen/DNA ecology.

THE CLUMPS—The L4 and L5 points for Gold. They tend to collect debris.

THE SCIENTIST—Quinn Tuft's guardian of knowledge. Tribes elsewhere use the same term.

TREEFODDER—Used as a curse.

a treemouth tender, and all of us thrown out of Quinn Tuft, we can't even make promises—"

Clave broke in. "Alfin, you're for leaving too?"

"Yes."

"Jiovan?"

"What are we running from?"

"Maybe nothing. That mark wasn't tended for a long time. Treefodder, the drought could have killed them off! We could *settle* the far tuft—"

Merril broke in, though she was puffing from the climb. "Oh no. If everyone died there . . . we won't want to . . . go anywhere near it. Sickness."

"Are you for going back or going on?"

"I don't . . . back, I guess, but . . . let's get that . . . big fan fungus first. Wouldn't that impress the citizens! And smoke another nosearm . . . if we can. Far as that goes . . . we know there's meat to be hunted on the trunk. We should tell the Chairman that."

"Jayan? Jinny?"

"She makes sense," Jinny said, and Jayan nodded.

"Gavving?"

"No opinion."

"Treefodder. Glory?"

"Go back," Glory said. "I haven't tasted foliage in days and days."

Clave sighed. "If I was sure I was right, we'd go on. Aaall right." His voice became fuller, more carrying. "We'll have enough to carry anyway, what with the giant fan and whatever meat we find. Citizens, we've done very well for ourselves and Quinn Tuft. We go home as heroes. Now, I *don't* want to lose anyone on the way down, so *don't* take the tide for granted! It'll get

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stronger with every klomter. Most of the way down we'll need lines for the meat and the fan fungus—''

Their goals had become Clave's own. Gavving noticed, and remembered.

The flashers had come back. Minya watched them at their mating dance. Two males strutted before the same female with their wing-cloaks spread wide, and the female's head snapped back and forth almost too fast to see. *Decisions, decisions—*

''Something's been worrying you, woman.''

—decisions. Was it any of Smitta's business? Minya made a swift decision: she *had* to talk to someone, or burst. ''I've started wondering if, if I'm right for the Triune Squad.''

Smitta showed shock. ''Really? You were eager enough to join eight years ago. What's changed?''

''I don't know.''

But she did, and suddenly Smitta did too. ''Don't talk to Sal about this. She wouldn't understand.''

''I was only fourteen.''

''You looked older . . . more mature. And maybe the loveliest recruit we ever got.''

Minya grimaced. ''Every man in the Tuft wanted to make babies with me. I must have heard every *possible* way of saying that. I just didn't want to *do* that with anyone. Smitta, that's what the Triune Squad is for!''

''I know. What would I be without the Triune Squad? A woman born as a man, a man who wants to be a woman . . .''

''Do you ever want—'' What was the right word? Not *make babies*, not for Smitta.

''I used to,'' Smitta said. ''With Risher—he was a lot prettier once—and lately with Mik, the Huntmaster's boy.'' Minya flinched. Maybe Smitta noticed. ''We give all that up when we join. You just have to hold it inside. You know that.''

''Does anyone ever . . .''

''What? Quit? Cheat? Alse jumped into the sky, a little after I joined, but nobody really knows why. That's the only way to quit. If you get caught cheating, I can name some would tear you apart. Sal's one.''

Tight lips and clenched teeth held back Minya's secret. Now Smitta did notice. ''Don't get caught cheating,'' she repeated. ''Maybe you don't know how citizens feel about us. They tolerate us. We won't give the tribe babies, so we do the most dangerous jobs anyone can think of, and pay the debt that way. But you don't ask any ordinary man to, you know, help you be in both worlds.''

Minya nodded. Lips pressed together, teeth clenched: if only she had kept them that way when she was with Mik! Mik had been impossible to get rid of, eight years ago. How had he changed so much? *Would he tell?*

''Smitta—''

''Drop it, Sal's coming.''

Minya looked. There were *four* figures down there, four women rising on jets of sprayed gas and seeds; and they carried no water. Sal shouted something the wind snatched away.

''They're wasting jet pods,'' Smitta observed.

They were closer now, and in range

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Treefodder is anything that might feed the tree: excrement, or garbage, or a corpse.

TUFTBERRIES—Fruiting bodies growing in the tuft of an integral tree. They fruit and scatter seed only at the tuft closest to the Smoke Ring median.

VOY—See **LEVOY'S STAR.**

YEAR—Half of a complete circuit of the Sun around Levoy's Star, equal to 1.385 Earth years.

DIRECTIONS

OUT—Away from Levoy's Star.

IN—Toward Levoy's Star.

EAST—In the orbital direction of the gas torus.

WEST—Against the orbital direction of the gas torus. The way the sun moves.

WINDWARD—Into the wind.

LEEWARD—The direction toward which the wind blows.

PORT—To the left if your head is Out and you're facing West, or if your head is In and you're facing East, and so forth. Direction of the Ghost Child.

STARBOARD—Opposite port. Toward the Blue Ghost.

DOWN and **UP**—Usually applied only where tides or thrust operate.

The general rule as known to all Tribes is, "East takes you Out. Out takes you West. West takes you In. In takes you East. Port and Starboard bring you back." Even those Tribes who no longer can maneuver within the Smoke Ring know the saying.

to snag the bark. This time Minya heard Sal's joyful bellow.

"Invaderrrsss!"

CHAPTER 7: THE CHECKER'S HAND

The two triads moved inward, staying in cracks in the bark where they could. Every minute or so Denisse, a tall, dark woman of Thanya's triad, would pop up, look around fast, and drop back into the bark.

"We counted six of them around the tribemark," Thanya said. "Dark clothes. Maybe they're from the Dark Tuft."

"Intruders on the tree." Sal's voice was eager, joyful. "We've never fought invaders! There were some citizens thrown out for mutiny, long ago . . . some of them killed the Chairman, and the rest went with them. Maybe they settled in the Dark Tuft. Mutineers . . . Thanya, what kind of weapons were they carrying?"

"We couldn't go ask them, could we? Denisse says she saw things like giant arrows. I couldn't even tell their sexes, but one had no legs."

They veered to avoid a crack clogged with old-man's-hair. Smitta said, "Six of them, six of us, you may have missed a few . . . shall we send someone back for Jeel's triad?"

Sal grinned wolfishly. "No."

"And no," said Thanya for her triad.

Minya said nothing—her triad leader spoke for her—but she felt a fierce joy. Right now there was nothing she needed more than a fight.

Denisse dropped back from her next survey. Her voice was deadly calm.

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"Intruders. We have intruders, three hundred meters in and a hundred to port, moving outward. At least six, I counted."

"Let's go slow," Thanya said suddenly. "I'd like to question one. We don't know what they want here."

"Do we care? What they want isn't theirs."

Thanya grinned back. "We're not a debating team. We're the Triune Squad. Let's go look."

They worked their way along the bark. Presently Denisse poked her head up, dropped back. "Intruders have reached the Checker's Hand."

Clearing the trunk of parasites was one of the Triune Squad's duties. Fan fungi were dangerous to the tree, and edible besides; but one large and perfect fan had special privileges. Found twenty-odd years ago, it had been left to grow even larger. Minya had only heard of the squad's unusual pet. She eased her head above the bark . . .

They were there: men, women, looking entirely human. "More than six. Eight, nine, dressed like dirty civilians. Sooty red clothes, no pockets . . . they're chopping at the stalk! They're killing it, the Checker's Hand—"

Smitta screamed and launched herself across the bark.

No help for it now. Sal cried, "Go for Gold!" and the Triune Squad leapt toward the intruders.

The fan fungus reached out from the trunk like a tremendous hand, white with red nails. Its stalk, disproportionately narrow and fragile-looking from a distance, was still thicker than Gavving's torso. He set to chopping at it with his dagger. Jiovan worked the other side.

"We'll get it down the trunk," Jiovan puffed, "but how will we ever get it through the tuft to the Commons?"

"Maybe we don't," said Clave. "Bring the tribe to the fungus. Let them carve off pieces to suit themselves."

"Tear the fringe off first," Merril said.

The Grad objected. "The Scientist will want some of the red part."

"And try it on who? Oh, all right, save some fringe for the Scientist. Not a lot, though."

The stalk was tough. They'd made some progress, but Gavving's arms were used up. He backed away, and Clave took over. Gavving watched the cut deepen.

Maybe they'd weakened it enough?

He pounded a stake into the bark and tethered his line to it. Then he leapt at the fungus with the full strength of his legs.

The great hand bent to his weight, then sprang back, flipping him playfully into the sky. Floundering, gathering in his line, he saw what the others had missed through being too close to the trunk.

"Fire!"

"What? Where?"

"Outward, half a klomter, maybe. Doesn't look big." The sun was behind the out tuft, leaving the trunk somewhat shadowed; he could see an orange glow within a cloud of smoke.

A flicker at the corner of his eye. He pulled hard at the line before his forebrain had registered anything at all . . . and a miniature harpoon zipped past his hip.

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He yelled, "Treefodder!" Not specific enough. "Harpoons!"

Jiovan was stumbling, indecisive; a sharp point showed behind his shoulderblade. Clave was slapping shoulders and buttocks to send his citizens to cover. Something sailed past at a distance: a woman, a burly red-haired woman garbed in purple, with pockets clustered from breasts to hips, giving her a look of lumpy pregnancy. She flew loose through the sky while she pulled something apart with both hands. Something that glittered, a line of light.

Their eyes met, and Gavving knew it was a weapon even before she let it snap shut. He clutched the bark and rolled. Something came as a tiny blur, thudded into the bark alongside his spine: a mini-harpoon with gray and yellow flasher feathers at the butt end. He rolled again to put the fan fungus between them.

Clave was nowhere in sight. Purple-clad enemies sailed along the wall of bark, yelling gibberish and throwing death. The red-haired woman had a harpoon through her leg. She tore it loose, cast it away and sought a target. She picked the easiest: Jiovan, who wasn't even trying to seek cover. He took a second mini-harpoon through his chest.

They were using jet pods. A lean purple-clad man spotted Gavving; he pulled his weapon apart and a string snapped. He screamed in rage and opened a jet pod to hurl him down at Gavving. His other hand waved a meter's length of knife.

Gavving leapt out of his way, drew his knife, yanked at the line to pull himself back. The man smacked into the bark. Gavving was on his back before he could recover. He slashed at the man's throat. Inhumanly strong fingers sank into his arm like a swordbird's teeth. Gavving shifted his own grip and jabbed his knife into the man's side. *Hurry!* The grip relaxed.

The tree shuddered.

Gavving didn't notice at once. He was shuddering with reaction. He saw the great wall of bark shuddering too, decided it was the least of his problems, and looked for enemies.

The red-haired woman was coasting treeward not far out, ignoring the blood spreading across her pants; her eye was on the shuddering tree. Out of range? Gavving tried a harpoon cast and instantly dived behind the great fan.

Not necessary. He'd skewered her. She stared at him, horrified, and died.

Purple-clad enemies screamed to each other, voices drowned by a rising background roar. Jiovan was dead with two feathered shafts in him. Jinny held a smaller fan fungus in front of her, harpoon in her other hand. The Grad rolled out of a crevice in the bark, saw what Jinny was doing and imitated her. A mini-harpoon thudded into Jinny's shield, and she bared her teeth and launched herself in that direction, followed by Jayan and the Grad.

Gavving reeled in his harpoon. The dead woman came with it, her arms and legs jerking. A wave of nausea clawed at his throat. He worked his harpoon loose, and was minded to examine the peculiar gleaming weapon still clutched in the woman's hand. He wasn't given time.

The tree shuddered again. The bass background roar continued, a sound like worlds ripping apart. Bark slid past

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Gavving; the red-haired corpse tumbled, flailing. He was scrambling for a foothold when someone came at him from the side.

Dark hair, lovely pale heart-shaped face—purple clothing. Gavving thrust a harpoon at her eyes.

"The fire!" Thanya screamed. "It'll block us from the tuft! We've got to get past it!" She blew jet pods and was skimming outward across the bark.

Minya heard, but she didn't pause. Smitta was dead, and Sal was dead, and a single invader boy had killed them both. Minya stalked him.

The boy wore scarlet clothing, citizen's garb; his blond hair curled tightly as a skullcap; his beard was barely visible. His face was set in a rictus of fear or killing-rage. He thrust at her, threw himself back from her sword's counterthrust, lost his toe-grip on the bark. For an instant Minya was minded to go after him. Pierce him, kill him for the honor of Sal's triad, then go!

There wasn't time. Thanya was right. The fire could block them all, maroon them away from Dalton-Quinn Tuft . . . and there was Sal's bow to be recovered. Minya whirled and leapt away, and fired a jet pod for extra speed.

Sal's corpse floated free, her dead hand clutching the tribal treasure. Behind Minya the blond youth gripped bark to set himself and hurled his handarrow. Minya kicked to alter her course and watched the weapon whisper past her. She turned back as a shape popped up directly in front of her.

The shape was wrong, not human. It froze her for an instant. Minya hadn't quite grasped what was happening when a fist exploded in her face.

Gavving had ignored the yells from the purple-clad women. Now two were fleeing, firing jet pods to carry them outward along the trunk. Another leapt in a zigzag pattern along the bark. But the dark-haired woman who had tried to kill him was now moving crosswise, back to where Gavving had left . . . left a burly red-haired corpse clutching a curve of silver metal.

Merril popped out of a crack just in front of her. Merril's fist smacked into the stranger's jaw with a sound Gavving heard even above the—

—bass ripping sound he'd been ignoring while he fought for his life: a sound like the sky tearing apart. Now he heard the Grad shrilling like a cricket, a sound of panic, the words drowned in the roar.

But Gavving didn't need to hear. He *knew*.

"Clave! *Claaave!*"

Clave popped out of a deep crack and shouted, "Ready. What do you need?"

"We have to jump!" the Grad screamed. "All of us!"

"What are you talking about?"

"The tree's coming apart! That's how they survive!"

"What?"

"Get everyone to jump clear!"

Clave looked around. Jiovan was dead, floating tethered, but dead. The Grad was already loose in the sky, with line coiled! Gavving . . . Gavving moved across the shuddering bark, ripped something loose from a purple-clad corpse, continued in along the trunk.

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Jayan and Jinny weren't visible. Alfin snarled as he watched his enemies disappear into the outward smoke cloud. Glory and Merril watched too, not believing it.

Make a decision. Now. You don't know enough, but you've got to decide. It has to be you, it's always you.

Gavving. Gavving and the Grad were old friends. Did Gavving know something? He'd captured an invader weapon, and now he was far in along the trunk . . . headed for the meat they'd left when they went after the mushroom. Of course, they'd need food if they were to cast loose from the tree.

The Grad's mind could have snapped. But Gavving trusted him . . . and everything was happening at once: fire blazing on the tree, the trunk shuddering and moaning, strangers killing and then fleeing. . . . There were jet pods in Clave's pack. He could get his citizens back once things settled down. He bellowed, "Grad! Lines to the tree?"

"Nooo! Treefodder, *no!*"

"All right." He bellowed above the end-of-the-world roar. "*Jayan! Jinny! Glory, Alfin, Merril, everybody jump! Jump away from the tree! Do not moor yourselves!*"

Reactions were various. Merril stared at him, thought it over, pushed herself free. Glory only stared. Jayan and Jinny emerged from hiding like a pair of birds taking wing. Alfin clutched the bark in a deathgrip. Gavving? Gavving was working to free one thick leg of nose-arm meat.

The bark still shuddered, the sound filled tree and sky, the purple-clad killers were nowhere to be seen, and . . . nobody had gone after the giant fan fungus. Clave hurled himself at the stalk.

The fan bent under his weight, then tore loose and was turning end for end. Clave's fingers were sunk into white fungus. The tumbling thing seemed to be picking up speed. Faster, the bark raced beneath the tumbling fan fungus, faster . . . a fiery wind rushed past him and was gone before he could draw breath.

It wasn't possible. Bewildered, Clave saw tufts of flame receding in both directions. No tree. Citizens floundered in the sky. Even Alfin had jumped at last. But the tree, where was the tree? There wasn't any tree. Fistfuls of fungus turned to mush in Clave's closing fists, and he screamed and wrapped his arms around the stalk. They were lost in the sky.

CHAPTER 8: QUINN TRIBE

Wood snapped explosively, spattering Gavving with splinters as he leapt across the bucking, tearing bark. A million insects poured from a sudden black gap that must have reached a klomter into the heartwood. Gavving cried out and waved his arms through the buzzing cloud, trying to clear enough air to breathe.

The tree was everything that was, and the tree was ending. If he'd stopped to think, his fear would have frozen him fast. He held to the one thought: *Get the meat and get out!*

The nose-arm legs tumbled loose within a cloud of burning coals. One haunch was in reach. Gavving caught a line to pull it free of the coals, then

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jumped to catch it against his shoulder. Hot grease burned his neck. He yelled and thrust himself away.

Now what? He couldn't *think* in this end-of-the-world roar. He doffed his backpack, tied it against the nose-arm leg, braced against the pack and pushed himself into the sky.

Clouds of insects and pulverized wood half-hid the shuddering, thundering tree. Dagger-sized splinters flew past.

Gavving braced one of his jet pods against the pack and twisted the tip. Seeds and cold gas blasted past him. The pod ripped itself free of his hands, spat seeds into the flesh of his face, and was gone.

His hands shook. Beads of blood were pooling on his cheek and his neck. He dug out his remaining jet pod and tried again, his tongue between his teeth. This time the pod held steady until it had gone quiet.

The world came apart.

He watched it all, while his terror changed to awe. Fiery wind swept past him and left him in the open sky. Two fireballs receded in and out, until the home tree had become two bits of fluff linked by an infinite line of smoke.

Awesome! Nobody could hope to live through a bigger disaster. All of Quinn Tribe must be dead . . . the idea was really too big to grasp . . . all but Clave's citizens, and they'd lost Jiovan too, and who was left? He looked about him.

Nobody?

A cluster of specks, far out.

He'd used both his jet pods, and now he was lost in the sky. At least he wouldn't starve. . . .

* * *

Thrashing his arms didn't stop the Grad's spin. He wasn't willing to use his jet pods for only that. He settled for spreading his arms and legs like a limpet star, which slowed him enough to search for survivors.

The left side of his face was wet. His fingertips traced a bloody gash that ran from temple to chin. It didn't hurt. Shock? But he had worse to worry him.

Three human shapes tumbled slowly nearby: purple marked with scarlet. His stomach lurched. It was their own doing; he hadn't come here to kill.

The giant fan fungus floated free, turning, turning to reveal Clave clutching the stalk. Good. Clave still wore his backpack: *very* good. That was their store of fresh jet pods. Then why wasn't Clave doing something about rescue?

Feet outward, Jayan and Jinny rotated slowly around their two pairs of clasped hands. It looked almost like a dance. Spreading out like that greatly reduced their spin. Good thinking, and no sign of panic.

Merril was a fair distance in. Her arms hadn't pushed her far, and the tree's wind-wake had caught her.

The world's-end roar had dwindled, allowing lesser sounds. The Grad heard a thin wail. Alfin had leapt free after all. He was thrashing and spinning and crying, but he was safe.

The Grad couldn't find Gavving, nor Glory, nor Jiovan. Jiovan's corpse must have gone with the tree, but where were the others? And why wasn't Clave doing something? He and the fan were drifting away.

The Grad sighed. He shrugged out of his backpack and searched out his jet

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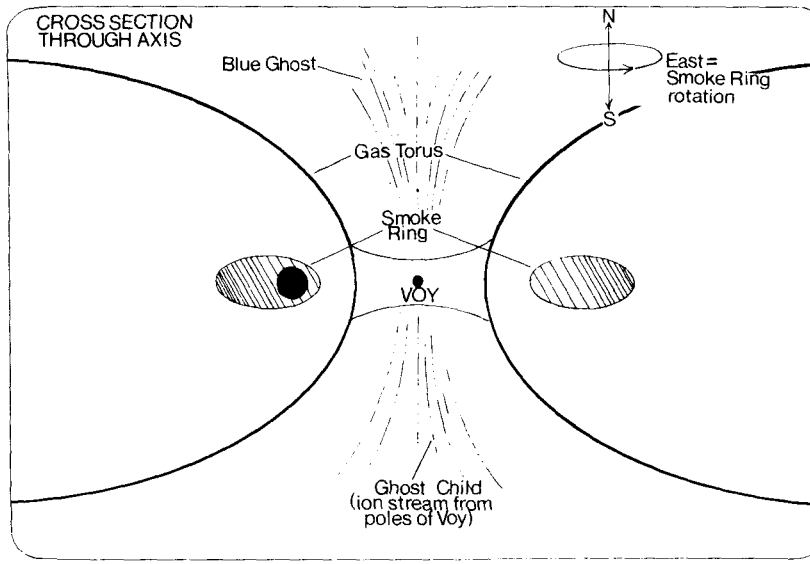

pods. Old jet pods, from Quinn Tuft stores. Were they still active?

He'd never fired a jet pod. He knew nobody who had. Hunters carried them in case they fell into the sky; but no hunter lost in the sky had ever returned in the Grad's lifetime. He did it carefully: he donned his pack again, then clutched a jet pod in both hands over his navel. When Clave was approximately behind him, he twisted the tip, smartly.

The pod drove into his belly. He grunted. He maneuvered the point, hoping to kill his spin. The push died; he released the pod, and it jumped away on the last of its stored gas.

Looking over his shoulder, he found the fan fungus drifting toward him. Clave still wasn't doing anything constructive, and he hadn't noticed the Grad.

The smoke of the disaster split the sky from end to end. Dense, flickering black clouds were pulling free of the paler smoke. The same insects that had eaten the tree apart were now casting loose to find other prey.

Other debris floated in the smoke trail. The Grad made out great fragments of torn wood and bark; a cloud of flashers whirling in panic; a flapping mote, perhaps a nose-arm fled from its burrow. In that confusion he could still see that the cloud of citizens and corpses was slowly drifting apart.

Far in toward Voy, Gavving maneuvered half his own weight in smoked meat. He'd be hard to reach. He'd gone far to save that meat, and the wind-wake must have pulled him farther. Save Gavving for last, and hope.

The fan brushed against the Grad and

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he clutched it, fungus springy under his hands. Clave watched as if bemused. He asked, "What happened?"

Safe now. "The tree came apart. Clave, I'm going to dig in your pack. We've got to start rescuing citizens."

Clave neither helped nor resisted as the Grad searched through his pack. They could use the big fan as a base of operations . . . rescue Alfin first, because he was nearest . . . He took half a dozen pods. He slid to somewhere near the fan's center of mass and fired a jet pod, then another.

"The *tree* came apart?"

"You saw it."

"How? Why?"

The Grad was judging distances. He cast a line in a wide circle. It brushed Alfin's back, and Alfin convulsed and snatched the line in a deathgrip. He didn't try to reel it in. The Grad had to do that, while Alfin watched in near-mindless terror. Alfin lunged across the last meter or so and wrapped himself around the stalk and buried his fingers in white fungus to the last knuckle.

A hand closed around the Grad's neck. Long, strong fingers overlapped the thumb, tightening like a steel collar. Clave's voice was a hot snarl in his ear. "You'll tell me now!"

The Grad froze. Clave had gone crazy.

"Tell me what happened!"

"The tree came apart."

"Why?"

"Maybe the fire set it off, but it was ready. Clave, everything in the Smoke Ring has some way of getting around. Some way to stay near the median . . . middle, where there's water and air. Where do you think jet pods come from?" The hand relaxed a little, and the Grad kept talking. "It's a plant's way of getting around. If a plant wanders out of the median, too far into the gas torus region—"

"The what?"

Alfin asked, "What on Earth is going on?"

"Clave wants to know what happened. Alfin, can you steer this thing and pick up some more of us? Here—" He passed across his store of jet pods.

Alfin took them. He took his time deciding what to do with them, and the Grad ignored him while he lectured. "The Smoke Ring runs down the median of a much bigger region. That's the gas torus, where the molecules . . . the bits of air have long mean-free-paths. The air is very thin in the gas torus, but there's some. It gets thicker along the median. That's where you find all the water and the soil and the plants. That's what the Smoke Ring is, just the thickest part of the gas torus, and that's where every living thing wants to stay."

"Where it can breathe. All right, go on."

"Everything in the Smoke Ring can maneuver somehow. Animals mostly have wings. Plants, well, some plants grow jet pods. They spit seeds back toward the median where they can grow and breed, or they spit sterile seeds farther into the gas torus, and the reaction pushes the plant back toward the median. Then there are plants that send out a long root to grab anything that's passing. There are kites—"

"What about the jungles?"

"I . . . I don't know. The Scientist never—"

"Skip it. What about the trees?"

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"Now, that's really interesting. The Scientist came up with this, but he couldn't prove it—"

The hand tightened. The Grad babbled, "If an integral tree falls too far out of the median, it starts to die. It dies in the center. The insects eat it out. They're symbiotes, not parasites. When the center rots, the tree comes apart. See, half of it falls farther away, and half of it drops back toward the median. Half lives, half dies, and it's better than nothing."

Clave mulled that. He said, "Which half?"

"East takes you out, out takes you west, west—"

"What are you doing?"

"I'm trying to remember. We were too far in toward Voy, so our end—" It only hit him then. The revelation blocked his throat.

A moment later, so did Clave's fingers. "Keep talking, you copsik. I've had it up to here with you telling half a secret!"

Thickly the Grad said, "Mister Chairman, you may call me the Scientist."

The hand relaxed in shock.

"Quinn Tribe is dead. We are Quinn Tribe."

Alfin broke the long silence that followed that terrible declaration. "Are you happy, Grad? You were right. The tree was dying."

"Shut up," said Clave. He released the Grad's neck. Maybe that had been a mistake, maybe not; he'd have to apologize presently. For now, he clambered around to the edge of the fan. Jayan and Jinny were coming near, watching his approach alternately as they spun.

He'd never felt like this, so helpless, so fearful of making decisions. It bothered him that Alfin and the Grad had seen him like that. He tried his voice and found it normal:

"They're almost here. Good work, Alfin. Go for Merril next. I don't see Glory."

The Grad said, "I haven't seen her since . . . since." He rubbed his throat.

"She may not have jumped. Seven of us. Seven." He flung a line. Jinny snagged it in her toes, and Clave pulled them both in together. He said, "Welcome to what's left of Quinn Tribe."

They clung to Clave more in desperation than affection. Jinny pulled back to look into his face. "They're dead? All the rest?" As if she'd already guessed.

Alfin demanded, "Why didn't the Scientist see *that* coming?"

"He did," said the Grad.

"Treefodder. Why did he stay, then?"

"He was an old man. He couldn't climb fifty klomters of tree."

Alfin gaped. "But . . . but that's the same as murdering everyone who *could* climb!"

There wasn't time for this. Clave said, "Alfin, pay attention to what you're doing."

Alfin set off two jet pods, then another. The fan drifted toward Merril, who waited in what might be stoic calm. He murmured, "The children!"

Somewhere off to the side, there was motion.

What Clave had taken for a purple-clad corpse was floundering in air. Clave pointed. "One killer left."

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They watched. She wasn't floundering now. She'd tied a line to her long knife, and now she cast it out. She snagged a dead companion and reeled it in. She searched the corpse, then pushed off from it in the direction of the next.

She hadn't found much, but it must have been what she wanted. Now she fired two jet pods in turn. The thrust carried her in toward Voy. Alfin said, "She's not coming here. Or going home. What does she think she's doing?"

"Not our problem."

Merril caught a line thrown by Alfin and pulled herself close. By now there was no room to clutch the fan itself. Clave asked her, "Did you see any sign of Glory?"

"Hanging onto the bark for dear life, last I saw her. She was in the out section. Gavving's a good distance in."

"We'll go after him. I hope we get there in time."

By then it was obvious. The woman in purple had passed them and was heading toward Gavving.

Gavving watched her coming. There was little else he could do. When he could see her face he watched her watching him. The rictus of hate he'd seen earlier wasn't there. He saw close-cut dark hair, a triangular face with an oddly narrow chin; an expression that was thoughtful, judging.

She was going to go past.

He didn't know how to feel about that. He didn't want to die alone; but he surely didn't want to die with those mini-harpoons through him. She was close now. She reached behind her back for a tethered mini-harpoon. He could only try to put the meat between them as she pulled her odd weapon apart, looking him in the eye, and released it.

The feathered thing buried itself in warm meat.

Then Gavving moved in frantic haste, pulling his knife, reaching for her line—

Her words were strangely twisted, but he understood her. "No, no, no, let me live! I have water! I have jet pods! I beg you!"

It might be so. He shouted, "Freeze! Don't reel yourself in! I have to think."

"I obey."

She hung, tethered, motionless.

"You've got water and I've got food. What if you kill me and keep both?"

"My sword," she answered, and produced the long knife, and threw it. Startled, Gavving reached out and managed to catch it by the handle. "My bow," she said, and he had time to bed the knife in the meat before she threw him the pull-it-apart weapon. He caught that too.

Now what? She was just waiting.

"What do you want?"

"I want to join you, your people. There's nobody else."

He could festoon himself with his weapons and hers, and so what? With nothing between them but forty kilograms of smoked meat, either could snatch a weapon and kill the other at any time. He'd have to sleep sometime . . . and still she waited.

He thought suddenly, *Why not? I'm dead anyway*. He called, "Come on."

She coiled the line as she came. Gavving had been hanging onto his pack, but she hugged herself up against the meat with no thought for what it would do to her purple clothing. She

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worked a jet pod out of one of the dozen pockets that gave her body its shapeless, lumpy look. She set it and twisted the end. When it had expended itself there was some change in their velocity. She used another. Then another.

"Why were you carrying so many?" he asked.

"I took them from my friends."

From their corpses. Gavving turned away. Quinn Tribe now formed a single clump around—

"The Checker's Hand," said his enemy. He had trouble understanding her pronunciation. "They're all moored to the Checker's Hand. Good enough. Fans are edible. So is dumbo meat."

"I know that word. *Checker*: the Grad's used it, but he never tells anyone what it means."

"You should not have attacked the Checker's Hand. We tend it . . . tended it."

"Is that why you killed Jiovan? For a *fan fungus?*"

"For that, and for returning from exile. You were cast out for assassinating a Chairman."

"That's news to me. We've been in Quinn Tuft for over a hundred years."

She nodded as if it didn't matter. She was strange . . . she was a stranger. Gavving knew every man, woman, and child in Quinn Tuft. This citizen had dropped on him out of the sky, complete and unknown. He wasn't even sure he should hate her.

"I'm thirsty," he said.

She passed him a squeezegourd pod half full of water. He drank.

The clump that was Quinn Tribe seemed minutely closer. Gavving might have been imagining it. He said, "What do we do now? The way you use a jet pod, maybe you handle yourself better in the sky than we do. Can you tell us what to do next? Dalton Tuft—"

"Dalton-Quinn Tuft," she corrected him.

"Your half of the tree is probably safe, but it's being pulled out by the tide. I can't think of any way to reach it. We're lost." Then his curiosity suddenly became unbearable. "Who *are* you?"

"Minya Dalton-Quinn."

"I'm Gavving Quinn," he said for the second time in his life. The first had been at his rite of passage into adulthood. He tried again. "Who are you all? Why did you want to kill us?"

"Smitta was . . . excitable. Some of us are like that in the Triune Squad, and you were killing the Hand."

"Triune Squad. Mostly women?"

"All women. Even Smitta, by courtesy. We serve the tuft as fighters."

"Why did you want to be a fighter?"

She shook her head, violently. "I don't want to talk about it. Will your citizens accept me or kill me?"

"We're not—" Killers? He'd killed two himself. It came to him that if the Grad had taught him rightly, those times when the Scientist would have whipped them both for such talk, then . . . then Minya's half of the tree, falling out from Voy, was also falling out of a drought. So. "Can I tell them this? If we can get you back to the far tuft, you'll see to it that we're made members of your tribe. It looks better if I can say that. Well?"

She didn't speak at once, and then she said, "I have to think."

* * *

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The meat and the fan were passing at fair speed when Clave cast out a weighted line. He'd reserved their last pod. Another mistake, maybe. Now they'd have only one chance . . . but the dark stranger caught the line neatly and made it fast. They braced against their mutual spin.

Gavving shouted across the gap. "This is Minya of Dalton-Quinn Tribe. She wants to join us."

"Don't pull in yet. Is she armed?"

"She was."

"I want her weapons." Clave cast another line. An impressively thick bundle came back. Clave studied the haul: a knife the length of his own arm, a smaller knife, a bundle of mini-harpoons, and two of the pull-it-apart weapons, one of wood and one of metal. He preferred the look of the wooden one. The metal thing looked like it had been made from something else. By now he'd guessed how they must work, and he liked the idea.

Alfin said, "She tried to kill us all."

"True." Clave handed the Grad his last jet pod, not without reluctance. "Stop our spin. Wait. See that sheet of bark, out from us and not moving very fast? See if you can stop our spin and move us that way too."

Alfin persisted. "What are you going to do?"

"Recruit her, if she'll stand for it," Clave answered. "Seven citizens in a tribe is ridiculous."

"There isn't room to guard her."

"Where do you want to spend the rest of your life?"

The jet pod sprayed gas and seeds. The Grad said, "We won't reach the bark this way. Not enough push."

Alfin still hadn't answered. Clave told him, "Unless you've learned to like falling, I'd guess you want to live in an integral tree tuft. We now have a prisoner who lives in a tuft. We have the chance to earn her gratitude."

"Bring her in."

CHAPTER 9: THE RAFT

The pond was a small, perfect sphere, twenty klomters out from the Checker's Hand: a giant water droplet trailing a tail of mist in the direction away from the sun. When the sun shone through from behind, as it did now, Minya glimpsed shadows wriggling within it.

It was going to drift past.

The ends of the tree were far away and still separating: Dalton-Quinn Tuft drifting out and west, the Dark Tuft in and east. The smoke trail that joined them was growing faint, save for dark streamers that were indecisive clouds of insects.

Something surged from the pond, and the pond rippled and convulsed in its wake. The creature was big even at this distance. Hard to judge its size, but it seemed little more than a mouth with fins. Minya eyed it uneasily. It didn't seem to be coming toward them. It was flapping toward the smoke trail.

A loose cluster of citizens floated about the Checker's Hand. They couldn't all cling. There wasn't room, and the fungus wasn't holding together that well, either. They used spikes and tethers, and showed a reluctance to approach Minya too closely.

The old one, Alfin, clung to the stalk. His look of terror had smoothed out, but he wouldn't talk and he wouldn't move.

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The Grad studied her. He said, "Meen Ya. Have I got that right?"

"Close enough. *Minya*."

"Ah. Mineeya—if we could reach your end of the tree, could you help us join your tribe?"

Their eyes were on her. The old one's seemed desperate. Well, it had had to come. She said, "We have a drought. Too many mouths to feed already."

The Grad said, "Your drought's probably ending about now. There'll be water."

"You're the Quinn Tribe Scientist's apprentice?"

"That's right."

"I accept what you say. How long before that new water grows new food? In any—"

"There'll be meatbirds in the wind now—"

"I don't want to go back!" There, it was said.

Clave asked, "Did you commit a crime?"

"I was thinking about committing a crime. I would have *had* to. Please!"

"Leave it then. But if we spend our lives here, they're likely to be short. Any passing triune family would think we're some kind of mushroom tidbit. Or that flying mouth that came out of the pond a minute ago—"

"Can't we get to another tree, one with nobody in it? I know we can't go anywhere now, but if we *could* get to Dalton-Quinn Tuft, we could get to another tree, don't you think?" They weren't buying it. Distract them? "Anyway, we can do better than we're doing now. We should be eating the Hand, not clinging to it. It won't last long now that it's been picked. We need a place to moor ourselves."

She pointed. "That."

That was a ragged sheet of bark, ten meters long and half that wide, a couple of hundred meters away. Most of its spin had by now been lost to air friction. Clave—the Chairman?—said, "I've been watching it for the past day. It isn't getting any closer. Treefodder, if we could move ourselves I'd go for the pond!"

The Grad said, "Maybe the tree left a partial vacuum. That might pull it in. We can hope."

"We can do more than that. The bark may be close enough." Minya reached for the weapons.

A hand clamped on her wrist, the fingers circling almost twice around. "What do you think you're doing?"

Long, strong fingers, and no qualms about touching another citizen. There were men like this Clave in Dalton-Quinn Tuft. They had driven Minya into the Triune Squad . . . Minya shook her head, violently. She was his prisoner, and she had come as a killer. She spoke slowly, carefully.

"I think I can put a tethered arrow into that wood."

He hesitated, then released her. "Go ahead and try."

She used Sal's metal bow. The arrow slowed as it flew, and presently drifted. She tried another. Now two arrows floated at the ends of slack lines. There were murmurs of disgust as the boy Gavving reeled the lines in.

"I'd like to try that," Clave said, and took the bow. When he released it, the string brushed his forearm, and he cursed. The arrow stopped short.

Minya never dithered. She made de-

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cisions fast, important or no: that too had helped to put her in the Triune Squad. Now she said, "Hold your left arm straight and rigid. Pull as hard as you can. Swing the string a little right and you won't hit your arm. Look along the arrow. Now don't move."

She picked up the loop of line and hurled it as hard as she could in the direction of the sheet of bark. Now the arrow wouldn't pull so much weight. "Whenever you feel ready."

The arrow sped away. It ticked a corner of the bark and stayed. Clave put pressure on the line, slowly, slowly . . . it was coming . . . the arrow worked itself free.

Clave repeated the exercise with no sign of impatience. The bark was meters closer now. He reached it again, and pulled line in as if he were fighting some huge meatbird.

The bark came to them. Clave fired another arrow deep into the wood. They crossed on the line. Minya noticed Alfin's shuddering breath once he was safely moored to the bark.

And she noticed Clave's, "Well done, Minya." But he kept the bow.

"We'll use the other side of the bark for privacy," Clave instructed. "Now, the bark is all we've got, so there's no point in getting it dirty. When you feed the tree, the fertilizer should go outward."

"It'll float around us," Alfin said, his first words in hours. He must have seen how they looked at him. "Yes, I *do* have a better idea. Be at the rim when you feed the tree. The spin will throw it away from us. Won't it, Grad?"

"Yes. Good thinking."

Minya chewed on fan fungus. It was fibrous and nearly tasteless, but there was damp in it, and the damp was delicious. Minya looked longingly toward the pond, which was no closer. So near, so far . . .

They had eaten the smoked dumbo meat down to the bone, to prevent its spoiling. Maybe that had been a mistake. Their bellies were full, even overfull, but they were left thirstier yet. They could die of thirst here.

Aside from that, things were going well.

The golden-haired boy, Gavving: she had made a good choice there. Perhaps he thought he owed her his life. Perhaps it was true. Harmless as he looked, she had seen him kill twice. He'd make a better ally than enemy.

Alfin she couldn't judge. If he was *that* terrified of falling, he'd be dead soon anyway.

Merril was something else again. Legless, but she swung a fist like another woman's kick! After all she'd lived through, she must be tough. More: handicapped as she was, she'd be dead without friends. She must be well thought of, then. Minya intended to make Merril her friend.

The Grad was a dreamer. He'd never notice whether Minya was dead or alive.

Clave was the dominant male. Perhaps he still considered her an enemy. But she had brought them to this raft, and let Clave take the credit. It couldn't hurt. If Clave thought he needed her, she didn't care if he trusted her.

But what else might he want of her?

Jayan and Jinny: they *both* acted as if Clave belonged to them, or vice versa. Two women sharing a man was not un-

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heard of. They seemed to accept Clave's decisions. But would they resent a potential third? Best stay clear of Clave, if she could.

She could solve that problem, perhaps—

Merril spoke around a prodigious yawn. "Does it feel like sleeptime? I personally feel like I've been hit on the head."

Clave said, "I want someone awake at all times on each side of the tree. Is there anyone who *isn't* sleepy?"

"I'm not," said Alfin.

So Alfin and Jayan took the first day's watch. Gavving and Merril would be next, then—Minya ignored the rest. Physically and emotionally, she was exhausted. She settled for sleep, floating next to the bark, curled half into foetal position.

The sun was just passing to port of Voy. She half noticed activity as citizens took their turns behind the bark, feeding the tree. Clave and Jinny slapped bugs off each other. Jayan presently disappeared around the edge. Alfin . . . Alfin was hovering next to her. He said, "Mineeya?"

She straightened. "Alfin. What do you want?"

"I want you for my wife."

Suddenly she was utterly awake. She *could not* afford enemies now. She said carefully, "I had not considered marriage." *He hadn't recognized her uniform!*

"You'd be a fool to turn me down. What better way to become one of us?"

"I will consider what you say," she said, and closed her eyes.

"I'm a respected man. In Clave Tuft I supervised the tending of the treemouth."

Her arms hugged her knees and tightened her into a ball, without her volition.

Alfin's hand shook her shoulder. "Mineeya, your choices aren't wide, here on this sheet of bark. You came as a killer. Some of us may still see you that way."

He wouldn't leave her alone. Well. She tried to keep her voice cool, but she couldn't make herself uncoil, and it came out muffled. "Your argument is good. I should marry one of you. Clave is spoken for, isn't he?"

Alfin laughed. "Thrice."

"Amazing. And the Grad?"

"You're playing games with me. Consider my offer." Then he saw that she was sobbing.

Minya was horrified, but she couldn't stop. The sobs racked her like convulsions. She couldn't even muffle the sounds of distress. She wanted a man, yes, but not this man! Did she have a choice? She might find herself forced to mate this ugly, abrasive old man, only to prevent Quinn Tribe from killing her. Or she could speak of her oath to the Triune Squad, and never be mated at all. It was just too much.

"I—I'll come back when you're feeling better." She heard Alfin's distress and guilt, then quiet. When she forced herself to look, she saw him weaving among the sleepers—stealthily?—to reach the far edge of the bark.

She had lost her home, her family, her friends; she was lost in the sky, cast among strangers. *Copsik!* How could he inflict such a decision on her now? *Filthy treefeeding copsik!*

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The tears were drying on her face. At least no Triune Squad companion had seen her so shamed. It came to her that her tears had driven Alfin away . . . just as they had been her primary defense when she was fourteen.

But what could she *do?* She hadn't been quite fair to the old man. He had spoken a partial truth, one she'd already considered: marriage was the way into Quinn Tribe.

—And she found that she had made her decision after all.

Dared she sleep now? She must. The sun was a hand's breadth past Voy; and she curled up and slept.

When the sun neared Voy again, Minya woke. Some had the knack. Minya could tell herself when to sleep and when to wake, and she would.

She flexed muscles without moving much. She was thirsty. There was restless motion around her. The Grad seemed to be having a nightmare. She watched until he was quiet.

Alfin shook Gavving awake, then Merril. He settled down while Gavving disappeared to his post on the far side. Minya waited a little longer, for Jayan and Alfin to fall asleep.

Alfin clutched the bark with all his fingers and toes and, for all Minya could tell, his teeth. His face was pressed to the bark, denying the sky. He'd never sleep that way; but he wouldn't see her either.

She uncurled and made her way to the edge of the bark. Merril watched her go. Minya waved and pulled herself around to the smooth side of the bark sheet.

Gavving saw her coming. He started moving away from her—to give her privacy? She called, "Wait! Gavving!"

He paused.

"Gavving, I want to talk to you."

"All right." But he was wary.

She didn't want that. "I don't have any weapons," she said, and then, "Oh. I'll prove it."

"You don't have to—"

She pulled her blouse over her head and moored it to the bark. She came closer, wishing for toeholds to let her walk upright. This crawling lacked the dignity she wanted. At least she'd shed the lumpy-pregnant look of the Triune Squad.

She said, "There are no pockets in my pants. You can see that. I want to tell you why I can't go back to Dalton-Quinn Tuft."

"Why?" He was trying to keep his eyes off her breasts, on her face. "I mean, I'm willing to listen. I've got a name for asking embarrassing questions." He tried to laugh; it stuck in his throat. "But shouldn't everyone hear this?"

She shook her head. "They might have killed me, without you. Gavving, let me tell you about the Triune Squad."

"You told me. You're fighters, and you're all women, even the men."

"That's right. If a man wants to be a woman, or a woman doesn't ever want to be pregnant, she joins the Triune Squad. She can serve the tribe without making babies."

Gavving digested that. "If you don't want to make babies, they make you fight?"

"That's right. And it isn't just fighting. It's anything dangerous. This—" She pulled the rim of her pants down,

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and he shied, perhaps flinching at the scar. It ran half a meter from her short ribs past her hip. "Tip of a swordbird's tail. If my jet pod hadn't fired I would have been all over the sky."

She suddenly wondered if he might see it as a flaw, rather than a matter of pride. Too late . . . and better that he sees it now than later.

He said, "Three of us fought a swordbird a few waketimes ago. Two came back."

"They're dangerous."

"So. You don't like men?"

"I didn't. Gavving, I was only fourteen."

He stared. "Why would a man bother a fourteen-year-old girl?"

She hadn't thought she could still laugh, but she did. "Maybe it was the way I looked. But they all . . . bothered me, and the only way out was the Triunes."

He waited.

"And now I'm twenty-two and I want to change my mind and I *can't*. Nobody changes her mind once she's in the Triune Squad. I could be killed for even asking, and I *did* ask—" She caught her voice rising. This wasn't going as planned. She whispered, "He told me I should be ashamed of myself. Maybe he'll tell. I don't care. I'm not going back."

He reached as if to pat her shoulder and changed his mind. "Don't worry about it. We can't move anyway. If we could, well, an empty tree would still be a better bet."

"And I want to make babies," she said, and waited.

He *must* have understood. He didn't move. "With me? Why me?"

"Oh, treefodder, why can't you just . . . all right, who else? The Grad lives all in his head. Alfin's afraid of falling. Clave? I'm *glad* he's here, he's a good leader. But Clave's . . . type pushed me into the Triunes in the first place! He scares me, Gavving. I saw you kill Sal and Smitta, but you still don't *scare* me. I think you had to do that." She knew instantly that she'd said the wrong thing.

He started to tremble. "I didn't hate them. Minya, they were killing us! Without a word. They were your friends, weren't they?"

She nodded. "It's been a bad, bad waketime. But I'm not going back."

"All for a fan fungus."

"Gavving, don't turn me down. I . . . couldn't stand it."

"I'm not turning you down. I've just never done this before."

"Neither have I." She pulled her pants off, then didn't have a spike to tether them. Gavving saw the problem and grinned. He pounded a spike into the bark and added two tethers. One he tied to Minya's pants, then to his own pants and tunic. The other he tied around his waist.

"I've watched," he confided.

"That's a relief. I never did." She reached to touch what his pants had covered. A man had put his male member into her hand once, against her will, and it hadn't looked like this . . . except that it was changing before her eyes. Yes.

She had thought she could just let it happen. It wasn't like that. But she was used to using her feet as auxiliary hands, and thus she pulled him against her. She'd been warned against the pain;

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some of the Triunes had not joined while they were still virgins. She had known far worse.

Then Gavving seemed to go mad, as if he were trying to make two people one. She held him and let it happen . . . but now it was happening to her! She'd made this decision in the cool aftermath of disaster, but now it was changing her, *yes* she wanted them joined forever, she could pull them closer yet with her heels and her hands . . . no, they were coming apart . . . it was ending . . . ending.

When she had her breath back she said, "They never told me *that*."

Gavving heaved a vast sigh. "They told me. They were *right*. Hey, didn't you hurt?" He pulled away from her, a little, and looked down. "There's blood. Not a lot."

"It hurt. I'm tough. Gavving, I was so afraid. I didn't want to die a virgin."

"Me too," he said soberly.

A hand shook the Grad's ankle and pulled him out of a nightmare. "Uh! What . . . ?"

"Grad. Can you think of any reason Gavving shouldn't make a baby with a woman?"

"What then, a musrum?" His head felt muzzy. He looked around. "Who is it, the prisoner?"

Merril said, "Yes. Now, I don't see any reason to stop it, unless she's got something else in mind. I just want to keep an eye on them. But someone has to be on watch."

"Why me?"

"You were closest."

The Grad stretched. "Okay. You're on watch. I'll keep track of the prisoner."

Merril's glare lost out to a smile. "All right, that's fair."

The Grad heard voices as he poked his head around the edge of the bark. Gavving and Minya floated at the end of a tether, quite naked, talking. "A hundred and seventy-two of us," Minya was saying. "Twice as many as you?"

"About that."

"Enough to crowd the tuft, anyway. The Triune Squad isn't a punishment. It's a refuge. We *shouldn't* be having children any faster than we are. And I was good, you know. I fight like a demon."

"You needed a refuge from . . . uh, this?"

A laugh. "This, and being pregnant. My mother died of her fourth pregnancy, and that was me."

"Aren't you afraid now?"

"Sure. Are you volunteering to carry it for me?"

"Sure."

"Good enough." They moved together. The Grad was intrigued and embarrassed. His eyes shifted . . . and the sky had opened a mouth.

The shock only lasted a moment. A great empty mouth closed and opened again. It was rotating slowly. An eye bulged above one jaw; something like a skeletal hand was folded below the other. It was a klomter away and *still* big.

The beast turned, ponderously, still maintaining its axial rotation. Its body was short, its wings wide and gauzy. No illusion: it really was mostly mouth and fins, and big enough to swallow

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their entire bark raft. Sunlight showed through its cheeks.

It was cruising the clouds of bugs left in the wake of the disaster. *Not* a hunting carnivore. Good. But wasn't there such a beast in the Scientist's records? With a funny name—

Merril touched the Grad's shoulder, and he jumped. "I'm a little worried about the bug-eater," she said. "We're embedded in bugs, have you noticed?"

"Noticed! How could I not?" But in fact he had learned to ignore them. The bugs weren't stinging creatures, but they were all around the bark raft, millions and millions of winged creatures varying from the size of a finger down to dots barely big enough to see. "We're a little big to be eaten up by accident."

"Maybe. What's happening with—?"

"I would say Gavving is in no danger. I'll keep an eye open, though."

"Good of you."

"We're being watched."

Minya's whole body convulsed in reflex terror. Gavving said, "Easy! Easy! It's only the Grad."

She relaxed. "Will they think we're doing wrong?"

"Not really. Anyway, I could marry you."

He heard an incipient stutter when she answered, "Are you sure you want to do that?"

For a fact, he was not. His mind lurched and spun. The destruction of the tree had been no more disorienting than this first act of love. He loved Minya now, and feared her, for the pleasure she could give or withhold. Would she think she owned him? The lesson of Clave's marriage, what he knew of it, was not lost on him. Like Mayrin, she would be older than her mate. . . .

And none of that mattered. There were four women in Quinn Tribe. Jayan and Jinny were with Clave; that left Merril and Minya. Gavving said, "I'm sure. Shall we go make an announcement?"

"Let them sleep," she said, and snuggled close. Her eyes tracked a moving mouth sweeping through the clouds of bugs. It was closer now. It didn't have teeth, just lips, and a tongue like a restlessly questing snake. It rotated slowly: a way of watching the entire sky for danger.

"I wonder if it's edible," Gavving said.

"Me, I'm thirsty."

"There has to be a way to reach that pond."

"Gavving . . . dear . . . we need sleep too. Isn't your watch about over?"

His face cracked in a great yawn, closed in a grin. "I've got to tell someone."

The Grad was curled half into foetal position, snoring softly. Gavving jerked twice on his tether and said, "We're getting married."

The Grad's eyes popped open. "Good thinking. Now?"

"No, we'll wait till sleeptime's over. It's your watch."

"Okay."

CHAPTER 10: THE MOBY

Voices woke her. She came awake fully alert, thirsty, and nervous.

He was young. She had given him

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what he wanted, had virtually forced it on him. He would lose interest. He would remember that she'd tried to kill him. He'd had hours to change his mind—

The voices were some distance away, but she heard them clearly. "—ten years older than you, and you don't have the bride-price . . . but that's trivia. Six or seven days ago she was trying to kill us all!"

"She could have her pick of us." Clave speaking, and he was amused. "All but me, of course. You wouldn't like that, would you, loves?"

"I think it's wonderful," said Jayan or Jinny. The other twin said, "It's —hopeful."

"Gavving, you are not old enough to know what you're doing!"

"Feed it to the tree, Alfin."

Gavving noticed Minya when she stirred and pulled herself back to the bark. "Hello," he called. "Ready?"

"Yes!" Too eager? It was a little late to be coy! "What kind of ceremony will it be? We can't use mine. I left our Scientist in the Tuft." *And he'd have me killed.*

"There's that too," said Alfin. "The Scientist—"

The Grad said, "I'm the Scientist now."

Ignoring Alfin's contemptuous snort, he opened his pack and spread the contents. Packed in spare clothing were four small flat boxes of starstuff—plastic—and a flat, polished surface that was glassy, like the Chairman's mirror, but didn't reflect.

Quinn Tribe seemed as surprised as Minya. Gavving asked, "Have you been carrying that all along?"

"No, I materialized it from thin air. We Scientists have our ways, you know."

"Oh, sure."

They grinned at each other. The Grad picked up the mirror and one of the boxes. He fitted the box into the thick rim of the mirror. "Prikazyvat Menu."

The Grad's pronunciation had shifted; it was odd, archaic. Minya had heard the Dalton-Quinn Scientist speak like that. The mirror responded: it glowed like the diffuse nighttime sun, then bloomed with tiny black print.

Minya couldn't read it. The Grad apparently could. He pulled the box loose and substituted another. "Prikazyvat Menu . . . Okay. Prikazyvat Record," he said briskly. "First day since sleeptime, the first sleep following the breakup of the tree, year three hundred and seventy. Jeffer speaking as Scientist. Quinn Tribe consists of eight individuals . . . Prikazyvat Pause."

Then nothing happened, until Minya couldn't stand it any more. "What's wrong?"

The Grad looked up. His face was a mask of pain. A keening moan tore through his throat. Crystal lenses trembled over his eyes. Tears didn't run here, without tide to pull them.

Clave put his hand on the Grad's shoulder. "Take a minute. Take as long as you need."

"I've been trying not to . . . think about it. The Scientist. He knew. He sent these with me. What good does it do if we're dying too?"

"We're not dying. We're a little thirsty," Clave said firmly.

"We're all dead except us! I feel like recording it makes it real."

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Clave glared around him. The tears were about to become contagious. Jayan and Jinny were sniffling already. Minya had to remind herself that Dalton-Quinn Tuft still lived, invisibly far, somewhere.

Clave snapped, "Come on, Scientist. You've got a marriage to perform."

The Grad gulped and nodded. Teardrops broke loose and floated away, the size of tuftberries. He cleared his throat and said in a creditably crisp voice, "Prikazyvat Record. The tree has been torn in half. Seven of us survive, plus a refugee from the outer tuft. Marriage between Minya Dalton-Quinn and Gavving Quinn exists as of now. No children are yet born. Terminate." He pulled the box from the mirror and said, "You're married."

Minya was stunned. "That's it?"

"That's it. My first act as Scientist. Tradition says you should consummate the marriage the first chance you—"

"Just what have you got there?" Alfin demanded.

"Everything I need," the Grad said. "This cassette is recent records. It used to be medicine, but the Scientist ran out of room and erased it. We couldn't use that stuff anyway. Starmen got sick in ways nobody ever heard of, and used medicines nobody ever heard of either. . . . This cassette is life forms, this one is cosmology, this one is old records. They're all classified, of course."

"Classified?"

"Secret." The Grad started rolling the gear in clothing again.

Clave said, "Hold it."

The Grad looked at him.

"Is there anything in your classified knowledge that we might need to know, to go on living?" Clave paused, not long enough for the Grad to answer. "If not, why should we guard that stuff, or let you carry it to slow you down?" Pause. "If so, you're hiding knowledge we need. Why should we protect you?"

The Grad gaped.

"Grad, you're valuable. We're down to eight, we can't spare even one. But if you know why we need a Scientist more than an apprentice hunter, you'd better show us now."

It was as if the Grad had been frozen with his mouth open. Then . . . he gave a jerky nod. He chose a cassette and fitted it into the rim of the non-mirror. He said, "Prikazyvat find *moby*: em, oh, be, wye."

The screen lit, filled with print. The Grad read, " '*Moby* is a whale-sized creature with a vast mouth and vertical cheek slots that are porous, used as filters. It feeds by flying through clouds of insects. Length: seventy meters. Mass: approx eight hundred metric tons. One major eye. Two smaller eyes, better protected and probably near-sighted for close work, on either side of a single arm. It stays near ponds or cotton candy jungles. It prefers to be spinning, for stability and to watch for predators, since there is no safe direction in the free fall environment. Moby avoids large creatures and also shies from our CARMs. When attacked it fights like Captain Ahab: its single arm is tipped with four fingers, and the fingers are tipped with harpoons grown like fingernails.' "

Clave glanced over his shoulder. They had a side-view of the flying mouth. Despite the swarm of insects

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near the raft, it was going around them. "That?"

"I'd think so."

"Carms? Captain Ahab? Whale-sized?"

"I don't know what any of that means."

"Doesn't matter, I guess. So. It's timid, and it eats bugs, not citizens. Doesn't sound like a threat."

"And *that* is why you need a Scientist. Without the cassettes you wouldn't know anything about it."

"Maybe," said Gavving, "we don't want it to go around us."

He explained, stumbling a little. Nobody laughed. Maybe they were too thirsty. Clave studied the massive bug-eater, pursed his lips, nodded. . . .

Clave stood as Minya posed him, gripping the steel bow in his left hand, drawing the bowstring halfway back toward his cheek. It felt awkward. Instead of one of Minya's mini-harpoons, a meter and a half of his own harpoon protruded before him.

The moby was watching him. He waited until the creature's spin put the major eye on its far side. "Throw the line," he said.

Gavving hurled the coiled line toward the moby. Clave let it unroll for a moment, then sent the harpoon after it.

The harpoon wobbled in flight, until the trailing line dragged it straight again. With the steel bow and Clave's muscles to propel it, the massive harpoon might have flown as far as the moby. It didn't. It didn't even come close.

"Reel it in and coil the line," he told Alfin. To the others he said, "Arrows. Put some arrows in the beast. Get it mad. Get its attention."

The Grad's arrow went wide, and Clave stopped him from wasting another. Gavving's and Minya's were flying true, and each had fired another when Clave said, "Stop. We want it mad, not scared, not injured. Grad, how timid is that thing likely to be?"

"I read you everything I know."

Classified! The first chance he got, Clave was going through all of the information on all of those "cassettes." He'd make the Grad read them to him.

The moby's gauzy tail was in motion. It had spotted the harpoon's motion and was edging away. Then the first arrows reached it. One struck the fin, one a cheek, neither with any great force.

The moby convulsed. Its fins thrashed and it turned. A third arrow struck near its major eye. It turned to face them.

"Alfin, have you got that line coiled?"

"Not yet."

"Then hurry, you copsik! Are we all tethered?"

The sky had opened a mouth; it gaped and grew huge. A skeletal arm folded forward, presenting four harpoons. Alfin asked, "Do we want to hurt it now?"

Clave discarded the metal bow and took up the harpoon. "Treefodder. I want this in its *tail*."

The moby obliged. Its tail flicked forward—and they felt the wind—as it circled to examine the situation. As the tail came into sight, Clave cast. The harpoon struck solidly in the meaty part, ahead of the spreading translucent fin. The moby shuddered and continued to advance.

The "hand" lashed forward. Gavving whooped and leapt from between

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closing horn harpoons, away into the sky, until his tether went taut and pulled him around the edge of the bark. Minya yelled and slashed at the "hand." "Feels like bone," she reported, and swung again.

Clave snatched up another harpoon and jumped toward the tremendous face. He pricked the creature's lip before his line pulled him back. The great skeletal fingers curled around behind him. Minya's sword slashed at a joint, and one of the harpoon-fingers was flying loose.

The moby snatched its hand back fast. Its mouth closed and stayed that way. The creature backpedalled with side fins.

Gavving reeled himself back to the bark. They watched the moby turning, retreating.

The bark raft surged. The moby stopped, turned to look back. The raft was following it. It began swimming strongly against the air.

A point of sunlight blazed near the edge of the pond. Vagrant breezes rippled the surface. Shadows moved within. A distant seed pod sent a tendril growing across a klomter of space toward the water. Gavving licked his lips and yearned.

Tens of thousands of metric tons of water dwindled in their wake.

Clave was cursing steadily. He stopped, then said, "Sorry. The moby was supposed to dive into the water and try to lose us."

Gavving opened his mouth, reconsidered . . . and spoke anyway. "My idea. Why aren't you blaming me?"

"I'd still get the blame. I'm the Chairman. Anyway, it was worth a try! I just wish I knew where the beast was taking us."

They waited to learn.

Gavving's eyes traced the line of the Smoke Ring, congealing out of the background of sky into the pale blue of water vapor and distance. Toothpick-splinters, all aligned, might have been a grove of integral trees. Tens of thousands of klomters beyond, a clot of white storm marked Gold. A thickening halfway down the arch toward Voy would be the far Clump.

Here were all the celestial objects a child had once wondered about. Harp had told him that he might see them some day. More practical heads had denied this. The tree moved at the whim of natural forces, and nobody left the tree.

He had left the tree, and was married, and marooned, and thirsty.

Quinn Tribe clung along the forward edge of the bark raft. At Clave's insistence they had donned their packs. Anything could happen . . . but nothing had, except that the pond continued to dwindle.

"So near and yet so far," the Grad said. "Don't we still have a few jet pods?"

"Not enough." Clave looked around him. "At least we haven't lost anyone. Okay. We're moving, and we're moving *out;* that's good, isn't it, Scientist? Thicker air?"

"Thicker anything," said the Grad. "Air, water, plants, meat, meat-eaters."

The moby was turning, swinging gradually east, and slowing. Tiring. Its fins folded against its side, presenting

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a streamlined egg-shape to the wind; it continued to fall outward, towing the bark raft. The pond had become a tiny jewel, glowing with refracted blue Voy-light.

Clave said, "We'll cut loose as soon as we get near anything interesting. Integral tree, pond, forest, anything with water in it. I don't want anyone cutting the line too soon."

"Cloud ahead," Merril said.

A distant, clotted streamer of white fading into blue. Clave barked laughter. "How far ahead? Sixty, seventy klomters? Anyway, it isn't ahead, it's straight out from us. We're aimed almost east."

"Maybe not," said the Grad. "We're aimed out from east and moving pretty fast. Gavving, remember? 'East takes you out, out takes you west, west takes you in, in takes you east, port and starboard bring you back.' "

"What the treefodder is *that?*" Clave demanded. Gavving remembered, but he said nothing. It was "classified" . . . and the Grad had never told him what it meant.

But Minya was saying, "Every child learns that. It's supposed to be the way to move, if you're lost in the sky but you've got jet pods."

The Grad nodded happily. "We're being pulled east. We're moving too fast for our orbit, so we'll fall outward and slow down. I'll bet the moby is making for that cloud bank."

The moby's fins were spread and flapping slowly. There was nothing at all ahead of them, out to where the arch of the Smoke Ring formed from infinity. Minya moved her tether to bring herself alongside Gavving. They clung to the rim of the bark and watched the wisp of cloud out from them, and hoarded their thirst.

The sun circled behind Voy.

Again. Already they had moved many klomters outward; the day-night cycle had grown longer.

The cloud bank was growing. It was!

"It'll try to lose us in the fog," the Grad said with more hope than conviction.

The moby hadn't moved for some time. The spike that tethered the harpoon was working itself loose. Clave pounded another into the wood and wrapped the slack line around it. But the cloud bank was spreading itself across the sky.

Details emerged: streamlines, knots of stormy darkness. Lightning flashed deep within.

Jayan and Jinny took off their shirts. Alfin, enjoying the sight without questions, suddenly said, "They're right. Get our shirts off. Try to catch some of that wet."

Darkness brightened as the sun emerged below the edge of the cloud. It continued to sink. They watched the first tenuous edge of mist envelop them, and began flapping their shirts. Gavving asked, "Do you feel damp?"

Merril snarled, "I feel it, I smell it, I can't drink it! But it's coming!"

Lightning flashed, off to the west. Gavving felt the mist now. He tried to squeeze water out of his shirt. No? Keep swinging it. Now? He wrung the shirt tight and tried to suck it, and got sweaty water.

They were all doing it now. They could barely see each other. Gavving had never in his life seen such darkness. The moby was invisibly far, but they

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felt the tugging of the tether. They swung their shirts and sucked the water, and laughed.

There were big fat drops around them. It was getting hard to breathe. Gavving breathed through his shirt, and swallowed the water that came through.

Light was gaining. Were they were emerging from the cloud? "Clave? Maybe you want to cut that tether. Do we want to stay in here?"

"Anybody still thirsty?" Silence. "Drink your fill, but we can't live in here, breathing through our shirts. Let's trust the moby awhile longer."

The pale green light was getting stronger. Through thinning fog Gavving thought he could see sky . . . green-tinged sky, with a texture to it. Green? Was this some effect in his eyes, due to the long, abnormal darkness?

Clave bellowed, "Treefodder!" and swung his knife. The harpoon-tether sang a deep note, cut short as Clave slashed again. The line whipped free; the bark sheet shuddered.

Then they were out of the mist, in a layer of clear air. Gavving glimpsed the moby flapping away, free at last, and spared it only a glance. He was looking at square klomters of textured green, expanding, growing solid. It was a jungle, and they were going to ram.

CHAPTER 11: THE COTTON CANDY JUNGLE

The carm was like nothing else in the universe. It was all right angles, inside and out; all plastic and metals, unliving starstuff. The white light that glowed from the dorsal wall was neither Voylight nor sunlight. Weirder lights crawled across the control panel and the bow window itself. The carm was mobile, where London Tree moved only with the help of the carm. If London Tree was a living thing inhabited by other living things, then Lawri saw the carm as a different form of life.

The carm was a mighty servant. It served Klance the Scientist, and Lawri. Sometimes it went away into the sky with Navy men as its masters. This time it carried Lawri too.

It grated in her nerves that she was not the carm's master here.

Seen through the picture-window bow, the jungle was green dotted with every color of the rainbow—including overlaid scarlet dots that were heat-sources. The Navy pilot pushed the talk-button and said, "Let go."

Several breaths went by before Lawri heard, "We're loose."

The pilot touched attitude jet keys. A tide pulled Lawri forward against her straps. Warriors had been clinging to nets outside the hull. Now they swept into view of the bow window as the carm decelerated. A cloud of sky-blue men fell toward undulating clouds of green.

The pilot released the keys after (by Lawri's count) twelve breaths. She'd watched numbers flickering on a small display in front of him. He'd released at zero. And the jungle was no longer moving toward the carm's bow window.

"The savages haven't moved yet," he reported. He was ignoring Lawri, or trying to; his eyes kept flicking to her and away. He'd made it clear enough: a nineteen-year-old girl had no place here, no matter what the First said.

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"They're just under the greenery. Are you sure you want to do this?"

"We don't know who they are." The ancient microphone put a squawk in the Squad Leader's voice. "If it's just fighters, we'll retreat. We don't need fighters. If it's noncombatants, hiding—"

"Right."

"Have you found any other heat-sources?"

"Not yet. That greenery is a pretty good reflector unless you're looking right into it. We can pick up some meat. Flocks of salmon birds . . . Squad leader, I see something off to the side. Something's falling toward the jungle."

"Something like what?"

"Something flat with people clinging to it."

"I see it. Could they be animals?"

"No. I'm using science," the pilot said.

The display superimposed on the bow window showed scarlet dots clustered close. Warmer objects—salmon birds, for instance—showed more orange in that display. Ribbon birds showed as cooler: wavy lines of a darker, bloodier red . . . The pilot turned and caught Lawri looking.

"Learning anything, darling?"

"Don't call me *darling*," Lawri said primly/evasively.

"Pardon me, Scientist's Apprentice. Have you learned enough to fly this ship, do you think?"

"I wouldn't like to try it," Lawri lied. "Unless you'd like to teach me?" She wanted very much to try.

"Classified," the pilot said without regret. He returned to his microphone. "That thing hit pretty hard. I'd say it's

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not a vehicle at all. Those people may be refugees from some disaster, just what we need for copsiks. Might even be glad to see us."

"We'll get to you when we . . . can." The Squad Leader sounded distracted, and with reason. Spindly savages taller than a man ought to be were boiling out of the green cloud, riding yellow-green pods bigger than themselves. They were clothed in green, hard to see.

There was a quick exchange of arrows as the armies neared each other. London Tree's warriors used long footbows: the bow grasped by the toes of one or both feet, the string by the hands. The cloud of arrows loosed by the savages moved more slowly, and the arrows were shorter.

"Crossbows," the pilot murmured. He played the jets, kicking the carm away from the fight. Lawri felt relief, until he started his turn.

"You'll endanger the carm! Those savages could snatch at the nets!"

"Calm down, Scientist's Apprentice. We're moving too fast for them." The carm curved back toward the melee. "We don't want them close enough for swordplay, not in free fall."

If the Scientist had his wish, the carm would never be used for war at all. Putting his Apprentice aboard had been a major strategic victory. He'd told her, "Your sole concern is for the carm, not the soldiers. If the carm is threatened, it *must* be moved out of danger. If the pilot won't, you must."

He had not told her how to subdue a trained fighter, nor how to fly the ancient machine. The Scientist had never flown it himself.

Savages flew toward the bow window. Lawri saw their terrified eyes before the pilot spun the carm about. Masses thumped against the carm's belly. Lawri shuddered. She would do nothing, this time. She would more likely wreck the carm than save it . . . and there would be hell to pay even if she got home to London Tree.

The savages were grouping to attack again. The pilot ignored them. He eased the carm into the midst of his own warriors.

"Nice going. Thanks," said the radio voice. Lawri watched the cloud of savages advancing.

"We're all aboard," said the Squad Leader.

The carm turned and coasted across the green cotton, southwest. Savages screamed or jeered in its wake. They hadn't a hope of catching up.

There was time to look, and time to feel rising fear. Gavving tried to take it all in before the end.

It was curves and billows of green wall spotted with blossoms: yellow, blue, scarlet, a thousand shades and tones. Insects swarmed in clouds. Birds were there in various shapes, dipping into the blossoms or the insect clouds. Some looked like ribbons and moved with a fluttering motion. Some had membranous triangular tails; some were themselves triangles, with whiplike tails sprouting from the apex.

Far to the east was a dimple in the green, funnel-shaped, perhaps half a klomter across; distances were hard to judge. Would a jungle have a treemouth? Why would it be rimmed with gigantic silver petals? The biggest flower

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in the universe set behind the jungle's horizon as they fell.

The storm had hidden a jungle. He'd never seen one close, but what else could it be? The moby had planned this well, Gavving thought.

Birds were starting to notice the falling mass. Motionless wings and tails blurred into invisibility. Ribbons fluttered away, as if in a strong wind. Larger torpedo-shapes emerged from the greenery to study the falling bark sheet.

Clave was snapping orders. "Check your tethers! Arm yourselves! Some of those things look hungry. We'll be shaken up when we hit. Has anybody noticed anything I might miss?"

Gavving thought he saw where they'd strike. Green cloud. Could it be as soft as it looked? East and north, far away, more darting swarms of . . . dots at this distance . . . men?

"Men, Clave. It's inhabited."

"I see them. Treefodder, they're fighting! Just what we need, another war. Now what's *that?* Grad, do you see something like a moving box?"

"Yes."

"Well?"

Gavving located a brick-shape with rounded corners and edges. It was turning in sentient fashion, moving away from the battle. A vehicle, then . . . big . . . and glittering as if made of metal or glass. Men clung to its flanks.

The Grad said, "I never saw anything like it. Starstuff."

The aft end of the box was spiky with bell-shaped structures: four at each corner, and one much larger in the middle. Nearly invisible flames, not flame-colored but the blue-white color of Voy, puffed from some of the small . . . nostrils? The vehicle stopped its turn and surged back into the battle.

"That should do it," Clave said. Gavving turned and saw what he had been doing: setting his last jet pods to orient the turning raft, so that the underside would strike first. It seemed to be working, but the jungle was hidden now. Gavving clutched the bark, waiting. . . .

His head was ringing, his right arm was banged up somehow, his stomach was trying to find something to reject, and he couldn't remember where he was. Gavving opened his eyes and saw the bird.

It was torpedo-shaped, about the mass of a man. It hung over him, long wings stretched out and motionless while it studied him with two forward-facing eyes in deep sockets. The other side of its head bore a sawtoothed crest. Its tail was a ribbed fan; the four ribs ended each in a hooked claw.

Gavving looked around for his harpoon. The crash had bounced it free of his hand. It was meters away, slowly turning. He reached for his knife instead, and eased himself out of the greenery in which he was half buried. He whispered, "I'm meat. Are you?" intending it as a threat.

The bird hung back. Two companions had joined it. Their mouths were long and blunt, and closed. *They don't bluff,* Gavving thought.

A fourth bird skimmed across the green cloud, moving fast, right at his head. He scrambled for cover as the bird dipped its tail-hooks into the foliage and stopped dead. Gavving stayed where he

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was, half under the raft. The birds watched him mockingly.

A tethered harpoon thudded into a bird's side.

It screamed. The open mouth had no teeth, just a scissors-action serrated edge. The bird set itself whirling as it tried to snap at its belly. A third eye was behind the crest, facing backward.

The rest made their decision. They fled.

With his toes locked in branchlets, Alfin reeled the bird into knife range. By then Gavving had retrieved his own harpoon. He used it to pin the bird's tail while Alfin finished the kill, a performance that left Alfin's sleeves soaked in pink blood. A wide grin stretched his wrinkles into uncustomary patterns.

"Dinner," he said, and shook his head as if he'd drunk too much beer. "I can't believe it. We made it. We're alive!"

During all the years in Quinn Tuft, Gavving couldn't remember seeing Alfin grin. How could Alfin be consistently morose in Quinn Tuft, and happy while lost in the sky? He said, "If we'd hit something solid at that speed we'd all be dead. Let's hope the luck holds."

Missing citizens emerged from the green depths. Merril, Jayan, Jinny, Grad . . . Minya. Gavving whooped and gathered her in his arms.

Alfin asked, "Where's Clave?"

The others looked around. The Grad tethered himself to the bark and jumped toward the storm, with a turning motion. "I don't see him anywhere," he shouted back.

Jayan and Jinny burrowed into the foliage. Minya called, "Wait, you'll get lost!" and prepared to follow.

"He's here."

Clave was under the bark sheet. They moved it to expose him. He was half-conscious and moaning softly. His thigh bent in the middle, and white bone protruded through skin and blood.

The Grad hung back, squeamishly; but everyone was looking at him, and it was clearly the Scientist's job. He set Alfin and Jayan to holding Clave's shoulders, Gavving to pulling on the ankle, while the Grad moved the bones into place. It took too long. Clave revived and fainted again before it was finished.

"That flying box," Alfin said. "It's coming here."

"We're not finished here," said the Grad.

The starstuff box fell toward them through the clear air between foliage and storm cloud. Men garbed in sky-blue clung to all four sides. The glassy end faced them like a great eye.

Clave's eyes had opened, but it didn't seem he understood. *Somebody* had to do something. Gavving said, "Alfin, Minya, Jinny, let's get the bark sheet out of sight, at least."

They turned it edgewise and pushed it down into the greenery. Gavving moved after it, and Minya after him, forcing their way through the thicket into dark green gloom. The foliage was dense at the surface. Underneath were open spaces and masses of springy branchlets.

"Grad?"

The Grad looked up. "Scientist."

"All right, Scientist. I need a Scientist," Alfin said. "Can you leave him for a moment?"

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Clave was half-conscious and whimpering. He should be all right with two women watching him. "Call me if he starts thrashing around," he told them. He moved away, and Alfin followed.

"What's the problem?"

"I can't sleep."

The Grad laughed. "It's been a busy time. Which of us do you accuse of sleeping well?"

"I haven't slept since we reached the midpoint. We're in a jungle, we've got food and water, but Grad —Scientist—we're still falling!" Alfin's laugh surprised the Grad; it had a touch of hysteria in it.

Alfin didn't look good. His eyes were puffy, his breathing was irregular, he was as jumpy as tonight's dinner turkey. The Grad said, "You know as much about free fall as I do. You learned it the same way. Are you about to run amok?"

"Feels that way. I'm not helpless. I killed a bird that was after Gavving," and for that moment his pride was showing.

The Grad mulled the problem. "I've got a bit of that scarlet fringe from the fans. You know how dangerous it is. Anyway, you don't want to sleep now."

Alfin glanced at the sky. The starstuff box was taking its sweet time, but . . . "No."

"When it's safe. And I haven't got much."

Alfin nodded and turned away. The Grad stayed where he was. He wanted solitude to nurse his jumpy stomach. He'd never set a broken bone before, and he'd had to do it without the Scientist's help. . . .

Alfin made his way back toward Jayan and Merril and Clave. He looked back once; the Grad was looking at the sky.

He looked back again, and the Grad was gone. Jayan screamed.

The darkness and the strange, dappled shadows made them almost invisible, even to each other. "We can hide in here," Gavving said.

Minya was nodding. "Burrow deep. Stick together. What about Clave?"

"We'll have to pull him through. What looks like a good spot?"

"None of it," Jinny said. "It would hurt him."

Gavving tracked a dense cluster of branchlets back to a single spine branch. "Cut here," he told Minya.

She didn't have room to swing. She used the sword as a saw, and it took her a hundred breaths or thereabouts. Then Gavving pushed against the freed end and found that the entire cluster moved outward as a plug. He pulled himself into open air and looked about him. "Merril! Here!"

"Good," Merril called. She and Alfin towed Clave toward the opening, moving with frantic haste. The one-eyed box was too close. The occupants must be watching them by now.

They'd have to dig in fast, get lost in the deep branchlets. But— "Where's Jayan? Where's the Grad?"

"Gone," Merril puffed. "He's gone. Something pulled him down . . . into the thicket."

"What?"

"Move it, Gavving!"

They got Clave inside and pulled the plug-bush closed. Gavving saw that

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Clave's leg had been splinted with strips of a blanket and two of Minya's arrows.

"The men on the box," Minya said, "they'll follow us."

"I know. Merril, what got the Grad? An animal?"

"I didn't see. He yelled and disappeared. Jayan snatched up a harpoon and ducked through and saw people disappearing deeper in. She's trailing a line. Gavving, should we stop her? They'll trap her too."

Why did it all have to happen at once? Clave's leg, the kidnappers, the moving box— "Okay. The soldiers on the box would be fools to come in here. It's the natives' territory—"

"We're here."

"We're more desperate . . . never mind, you're right. We go after Jayan right *now*, because it gets us away from that starstuff relic. Merril—" Would Merril slow them down? Probably not, in free fall. Okay. "Merril, me, Minya. We'll follow Jayan and see what's going on. Maybe we *can* bust the Grad loose. Jinny, you and Alfin follow as fast as you can, with Clave. Merril, where's Jayan's line?"

"Somewhere over there. Treefodder, why does it all have to happen at once?"

"Yeah."

CONTINUED IN NEXT ISSUE

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IN TIMES TO COME

● Our cover story for December is "Cascade Point," by Timothy Zahn. The problem here is a neat interweaving of a possible future physics and human psychology; I can't explain in a few words exactly what the title means, but I can tell you it refers to an essential property of one of the more intriguing forms of "spacewarp" transportation I've seen. It's one of those developments that found engineering application before its principles were fully understood; one of its known side effects was a decidedly peculiar one whose consequences were definitely psychological, but those causes might lie in the mind, or the structure of spacetime, or both. And when a psychologist decided to try to use that effect in experimental therapy, a starship captain wound up with a dilly of a problem in navigation.

The issue will also feature Part III of Larry Niven's *The Integral Trees* and an assortment of other items including (barring the usual last-minute glitches) a Callahan story by Spider Robinson, a new way of economizing on space launches by Keith Lofstrom, and a guest editorial by Arthur C. Clarke.

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the reference library

By Tom Easton

Startide Rising, D. Brin, Bantam, $3.50, 352 pp.
The McAndrew Chronicles, C. Sheffield, TOR, $?, 244 pp.
The Anvil of the Heart, B.T. Holmes, Haven, $11.95, 313 pp.
Tsunami, C. Kilian, Douglas & McIntyre, C$16.95, 218 pp.
Earth Song, S. Webb, Atheneum, $12.95, 190 pp.
The Wind from A Burning Woman, G. Bear, Arkham House, $13.95, 271 pp.
Chrysalis 10, R. Torgeson, ed., Doubleday, $11.95, 182 pp.
Philip K. Dick, J.D. Olander and M.H. Greenberg, eds., Taplinger, $12.95, 256 pp.
Man and the Planets, D. Lunan, Ashgrove Press, £9.50, 306 pp.

Two columns ago, I remarked on how some of you readers have been writing Atlantic Richfield for copies of the *Tricentennial Report*, which I discussed last March, and not getting them. I've heard from more of you since then with the same story, and I've written to ARCO to apologize for inconveniencing them.

ARCO's L. C. Bershon has now written back, saying the requests continue to pour in, and marveling at the loyalty of my readers. That's you, folks. You're as loyal as any reviewer or writer could hope for, and I thank you. I also apologize for putting *you* out over the *Report*. I'll try to remember, next time I want to talk about something a few years old, to warn you it may be out of print!

Should I take advantage of your loyalty? There's some very idealistic "world peace" literature on the way to me, and I'm inclined to tell you at least a little about it once I've seen it. If that's taking advantage, so be it. I'll stop short of trying to sell you on the pro-tech, pro-space Congressional candidate who recently asked me to be his "scientific consultant."

To business—Books! I've just fin-

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ished a beauty, David Brin's **Startide Rising**. You saw part of it right here in *Analog*, as "The Tides of Kithrup," and that part was excellent. So's the rest.

Startide is the centuries-later sequel to Brin's *Sundiver*, which introduced us to a multigalactic civilization of species that had been "uplifted" to sentience by vanished elder species. Humanity had just hit the spacelanes, without a patron, or uplifter. It was a scandal, the more so because humanity was itself a patron, uplifting chimps and dolphins to join it in a vigorous defiance of traditions that had held for eons.

Worse yet, the species of Earth insisted on doing things their own way, refusing dependence on the Library, that compendium of all species' knowledge. They even presumed to *check* on the Library, and they actually found errors and omissions. Not surprisingly, the Earthlings had few friends. They were arrogant, pitiable orphans and wolflings. They should be adopted, redesigned, and properly trained by a hundred thousand years of indentured servitude to an established patron, in accord with the sacred customs.

Just before *Startide* opens, the ship *Streaker*, crewed by dolphins with one chimp and a handful of humans aboard, has been exploring. It found a fleet of derelict ships the size of moons, and it reported back to Earth. Other species, eavesdropping, decided to seize the *Streaker* and the fleet's coordinates on the assumption that the fleet meant the long-gone Progenitors were returning to judge and reward. They laid an ambush, which the *Streaker* escaped. Yet the Earth ship was damaged, and it had to land on the water-world Kithrup for repairs.

Here begins the story. The ship is hiding as its pursuers arrive and begin to war among themselves, each rapacious species wanting the Earthlings for itself. The story is one of successful repairs and escape, complicated by factional disputes, mutiny, romance, and individual heroism. This last element seems designed to remove the hero—an extremely able leader—from the ship and allow the disputes to bloom. Without the disputes, the book could have been much shorter and simpler. With them, the story stretches to allow much more character development and a satisfying richness of texture. Only occasionally did I wish for brevity—most of the time, Brin kept up the pace and held my interest unusually well. I fully expect to see the book on the Nebula ballot in a few months.

Brin has done an admirable job of imagining the personalities and thought processes of intelligent cetaceans (and other aliens). He has retained the idea of whale song, but modified it so his dolphins speak in poetic phrases with the flavor of haiku.

His chimpanzee seems less deft, for it smacks of stereotypes. Yet Brin is aware of this and he uses the chimp's own awareness of stereotyping to build its character and comment on the racist undertones of the novel's various conflicts. He also uses it in some of the humor that leavens his text, especially toward the end, when the tale's resolution lightens its tone enough to permit levity.

Need I add that I recommend *Startide Rising* most whole-heartedly? I do, and I fully expect you to love it.

TOR is bringing out Charles Sheffield's **The McAndrew Chronicles**, consisting largely of three *Analog* novelettes and two more from elsewhere. They cover the adventures of Jeanie Roker, narrator and spaceship pilot, and "Mac" McAndrew, physicist supreme

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and specialist in the miniature black holes called kernels. McAndrew and his tales are SF of the classic sort. He invents marvelous gadgets, not quite from a standing start, and the working out of their implications becomes story after story. Here the primary gadget is a new space drive, "inertia-less" because it uses the gravitational attraction of a disc of condensed matter to cancel the g-forces of acceleration. It works, of course, only if the drive has ample energy, meaning much more than even a matter-antimatter drive could supply. McAndrew meets this "if" by devising a way to tap the energy of the vacuum, which Sheffield says amounts to the energy equivalent of two billion tons of mass per cubic centimeter of vacuum.

"WOW!" as they say. "Gee whiz!" I'm hardly physicist enough to criticize Sheffield on such points, not even when he goes to the trouble of giving his yarns an appendix wherein he discusses just how reasonable his speculations are or are not. Yet I do have questions he fails to answer: What happens to the vacuum—to space itself—when you extract its energy? I think of other stories which have called for an effect akin to pricking a balloon, and hence the destruction of the universe as soon as the drive is turned on (the zone of destruction expands at light speed). *Something* has to happen! Doesn't it?

Another question: One of his ships hovers in a 50-g gravity well, its throttle stuck at maximum, countering gravity with a 50-g thrust. The story ends when the characters find a way to unstick the throttle, knocking it down to a 20-g thrust (I simplify just a bit). The ship then returns to Earth, after presumably escaping the 50-g gravity with only 20 g of thrust. Huh? How? It can be done, I guess, if the ship just keeps moving long enough. But Sheffield, though he gives plenty of detail for his technical novelties, neglects us astronautical meatheads who need to have even the trivial spelled out.

And another question: His last tale is "Rogueworld" (from *F&SF*), and in it a world isolated for millions or billions of years has so built up imbalances in its crust that a single landing is enough to trigger violent, worldwide spasms. Maybe so, but I suspect a touch of mysticism here, and I doubt this scenario more than any other.

Enough quibbling. If you enjoyed Sheffield's McAndrew yarns in this magazine, you'll enjoy the book, and you'll get two more yarns and a long lecture to boot. So buy it, already.

Anvil of the Heart comes from the Haven Corporation, at 802 Madison Avenue, Evanston, IL 60202, which if I recall correctly is in a residential neighborhood within a few blocks of where I used to live in that town. I'm guessing that Haven is a small outfit. It may even be a back-bedroom, self-publishing operation, but the product is on a par with that of many larger, "legit" outfits. Both package and contents might have come from, say, Random House. If you see the book in a bookstore, you won't be put off by its appearance.

The author is Bruce T. Holmes, who teaches the Feldenkrais Method, apparently a relaxed and vital style of body movement. He is also a black belt Aikidoist, a marathon runner, and a member of a performing dance troupe. And from the photo on the back of the dust jacket, I ought to know him. He looks *awfully* familiar! But I can't, for the life of me, place him. Neither can my wife, and we're both frustrated. Are our aging memories failing? Or did we meet him

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just once or twice? Maybe he'll write, laughing, to remind me we used to play chess together. Or to say he ran the frame shop around the corner. Or . . .

Given Holmes's apparent place in the "human potential" business, it's not too surprising to find reflections in his story. In Holmes's future, humans have tinkered with their own genes. They have designed *Homo superior* to mature young, to outclass its parents in intelligence, and to be free of distracting emotions. So much is SF cliché. A bit more worthy is what Holmes does with it. The new- and old-model humans share the world, but the new models are Teutonic *übermenschen*, planning for the day the old are extinct and even willing to hasten the day with pogroms. Some old-model men have jobs as police or scholars. Most have only a grudging dole, and they are ripe for rebellion. There are also rebels.

The story begins when an old model scholar falls in with the rebels. He learns Aikido, self-assertion, and independence from an aged guru, and he becomes the rebel leader. In the end, he leads the rebellion that restores the world to true humanity.

It's not a bad yarn. It moves well, and in parts it lives. It suffers largely because both its derivativeness and its didacticism show too clearly. Holmes wants to dramatize the idea of human potential, and he lets us catch him at it.

The book also suffers for lesser reasons. One is quite simply the early maturation of his new humans. They are supposed to be a step forward in evolution, yet evolution itself teaches us that the tendency is to *later* maturation, longer postnatal periods of brain growth and learning from parents. Another is that though he claims his new models are callous and emotionless, they display quite recognizable feelings of pride, disgust, fear, and disdain. The real difference between models, as he draws it, is one of communication—they have great difficulty reaching each other. Yet, given this, he ignores the reality that it is quite possible for different species to communicate with each other. Humans and dogs all but talk together. Humans and chimps *can* talk. And then there's that wildlife biologist who made front pages by prancing a mating dance with a whooping crane! Perhaps Holmes's models just don't try —but then he has a very different story, and one that might have been better told with less extreme contrasts.

Crawford Kilian has given us *Eyas*, of a far-future Earth, and *Icequake*, of a near future when the Antarctic icecap slides into the sea and floods the world's coasts with tidal waves. Now he gives us **Tsunami**, in which the Antarctic icecap slides into the sea and floods . . . Wait a minute! *Is* he repeating himself as closely as I make him sound? No. *Icequake*'s focus was on Antarctica and on post-flood New Zealand. *Tsunami*'s focus is on California, land of earthquakes and mudslides, with a sidetrip to Vancouver, B.C. Kilian tells us what it's like to be driving across the Golden Gate Bridge when the traffic stops to rubberneck a tidal wave, even as the wave destroys the bridge and swamps the Bay area. He tells us who survives to rebuild and how, with what honor or dishonor. He's grittily realistic, and the book is a very fast read.

Kilian could have gotten away with moving the *Icequake* story elsewhere. That disaster was certainly large enough to justify a handful of novels—New Zealand, California, Japan, London, etc., before, during, after, and ten years after. He doesn't quite do that, although perhaps he was tempted. Here the dis-

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aster's makings are different, and the disaster itself has extra features. The Earth has lost its protective magnetic field and ozone layer. The sun is flaring, and ultraviolet blasts are killing plants and animals and blinding people who forget their sunglasses and sunblock cream. Nations totter. And then come the icequake and the tsunamis. It would have been so easy for Kilian to kill everyone off, but he doesn't, and the book actually ends on an upbeat note.

Buy it.

Sharon Webb's last book was *Earthchild*. I praised it, and I can praise its sequel, **Earth Song**, too. Here Earth's immortals have integrated Webb's solution to their loss of creativity—a class of blessed mortals to serve as artists and scientists—but the integration is threatened. A warped and jealous child has grown into a warped and jealous immortal, a Loki among the gods who creates his own religion and his own storm troopers and seems ready to destroy everything. At the same time, other forces move. Empathic powers emerge among the retarded. Love blooms. A starship is readied. And all come together to give us a vision of growth. The book is for "young adults," and so a theme of promise, of a blooming future and the laying of night terrors, is apropos. Yet in this world of ours, such themes can also hearten older adults. Buy the book for your teenager, but read it yourself too.

The third volume of the trilogy will be *Ram Song*. Presumably it will take place aboard the starship Ram, launching at *Earth Song*'s close. The continuity will come with the presence of Kurt, hero of *Earthchild*, the minister of culture who devised the idea of mortal creativity, and the parental figure of *Earth Song*. What will his role become? Anyone who has read the first two volumes will be curious enough, and optimistic enough about the author's skills, to buy the third. And that, after all, is a large part of the rationale for trilogies. Isn't it?

Greg Bear's **Wind from A Burning Woman** collects half a dozen short stories and novelettes. There's "Mandala," part of his novel, *Strength of Stones*. There's the title story, with its concern for the justification of terrorism; "The White Horse Child," which confronts an embryo story teller with stuffy elders and gives creativity its magical due; "Petra," in which chaos rules, stone lives, and mind defines reality; "Scattershot," in which the inhabitants of many universes meet in limbo; and "Hardfought," in which engineered warriors redefine humanity. To my mind, this last may be one of Bear's best stories, for it blends his customary sensitivity and imagination with a breathtaking scope. He is one of SF's finest, no journeyman tale-teller but an artist of the imagination.

It's been awhile since we've seen a *Chrysalis*. Roy Torgeson seems to have slowed down just a bit. Yet he's still doing good work. **Chrysalis 10** is very much what we expect from him, good stories, often of a sort we don't see elsewhere. For instance, look at Jay Parry's "Moulder Moulder," in which even murder won't get someone off your back, and murderers find "on your back" addictive. Try Dave Bischoff's "The Warmth of the Stars," in which a girl learning to accept isolation before taking her place in her people's group mind meets and loves a nontelepath; Tanith Lee's "As Time Goes By," set on a station where time flows cross and love finds new paths; Steve Rasnic

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Tem's "Mechanic," which offers an ominous explanation of highway deaths; Andrew Weiner's "One More Time," where a man proves unable to edit his past to his own satisfaction; Roger Zelazny's "Devil and the Dancer," a tidbit adventure of Dilvish the Damned; and others by Tom Monteleone, Leanne Frahm, Connie Willis, and Gardner Dozois. Best of the lot is Tetsu Yano's "The Legend of the Paper Spaceship" (translated admirably by Gene Van Troyer and Tomoko Oshiro); it concerns a village whore who may or may not be the last survivor from a crashed spaceship, her bastard son, and her village; it's a very warm and human tale, with a chilling close.

Philip K. Dick is gone. His work remains, and so do the critics. Joseph Olander and Martin Greenberg have drawn a few of the latter together in **Philip K. Dick**, the latest in Taplinger's Writers of the 21st Century series. Some of the essays are reprints (including Dick's own "Now Wait for This Year"). Some are new. Only Barry Malzberg's introduction even mentions Dick's last few books. With Dick dead a year ago, and with the books available in plenty of time for discussion here, this seems odd. Perhaps the critics need more time to figure what to think of them.

The critical consensus seems to be that Dick was a hasty, first-draft writer, frequently pedestrian but always of undeniable genius. He often dealt with machines, robots, as reality and metaphor. Patricia Warrick, who wrote *The Cybernetic Imagination in SF*, sees him as exploring the nature of humanity through its reflections in its artifacts. Eugene Warren sees Dick as seeking the nature of God in the same way.

In other contributions, Tom Disch discusses the transcendent in *Solar Lottery*, Warrick encounters taoism and fascism in *The Man in the High Castle*, N. B. Hayles finds metaphysics and metafiction in the same book, Darko Suvin sees artifice as refuge and world view, Brian Aldiss finds a maledictory web, Hazel Pierce looks for political dreams, and Michael Bishop and Peter Fitting pursue *Ubik*. The book closes with a biographical note and a bibliography.

Two years ago I reviewed Duncan Lunan's *New Worlds for Old* favorably. Now I have his **Man and the Planets: The Resources of the Solar System**. It too is an outgrowth of ASTRA (Association in Scotland To Research into Astronautics) discussions featuring experts and enthusiastic amateurs, and it argues effectively for getting into space. It reviews shuttles, launch vehicles, bootstraps, skyhooks, colonies, and ships, the resources and benefits and spinoffs, always thinking very big indeed. It often credits SF with ideas, and it cites *Analog* from time to time. It is a mine of ideas for (and from) SF stories and for high-tech bull sessions galore. It's a wish-book.

Lunan makes the strong point that the mission-oriented approach to space is a useless mistake. What we need is the strategic approach first advocated by Krafft Ehricke in 1968. Here no mission flies for its own sake alone. The goal becomes the building of capabilities on the way to exploiting the Solar System as storehouse and workshop.

With luck, Lunan will again find a U.S. publisher. He doesn't have one yet so far as I know, so if you want the book you'll have to order it from Ashgrove Press, 26 Gay Street, Bath, Avon BA1 2PD, Great Britain.■

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brass tacks

Dear Sir,

Your magazine takes a little time to arrive in this corner of the world, but it is appreciated when it does. I am moved to write by the serial *Rocheworld* by Robert L. Forward. I enjoyed this immensely, and hung about by the mail box waiting impatiently for each installment. Then I reread the whole story when I had finished the concluding installment. I was reminded of the stories of Hal Clement, and especially of my old favourite, *Mission of Gravity*. I intend that remark as high praise, and if you are offered any more stories by Dr. Forward, especially if they're set in the Barnard's Star system, please grab them with both hands.

I also enjoyed "Taking the Fifth" by Hayford Peirce in the January '83 issue. Stories that point out the fishhooks in attractive-looking bait are both entertaining and thought-provoking, which are timely qualities in hard times.

Many thanks for your fine work, and keep up the effort; it is appreciated.

COLIN H. PARKER
Auckland, New Zealand

Dear Mr. Schmidt:

All questions on the nature of the NASA bureaucracy aside, Jerry Pournelle's "Dry Centaur" Alternate View (May) raises some interesting questions. As an engineer involved in the ongoing effort to integrate the Centaur into the Shuttle, I'd like to clarify some points Jerry made.

1. There isn't a lot of LO_2 and LH_2 in the External Tank to scavenge. The NASA version of the Centaur that will be used on the Galileo mission carries 38,300 lbs. of LO_2 and 7,600 lbs. of LH_2, not including the propellant expended during chilldown of the tanks. As a comparison, the most recent *Columbia* flight had only 5,700 lbs. of LO_2

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and 3,200 lbs. of LH_2 left at main engine cutoff. To carry the additional propellant in the ET would require an expensive redesign effort.

2. Dump plumbing (which is of 5″ diameter, not 17″ as Jerry stated) is required not only for RTLS aborts, but for any abort that occurs after the Centaur is filled. A failure of the Centaur deployment system would necessitate a dump prior to the return of the Shuttle with the Centaur on board. You can't get rid of the dump system by going to Dry Centaur.

3. The plumbing to get propellant from the ET to the Centaur would be no lighter than the present design. In addition, heavy and power-hungry pumps would be required. The present loading procedure takes one and a half hours to load the Centaur with the high flow rates available from ground pumps. To fill the Centaur after 100,000-ft. altitude is reached, you have only six and a half minutes left to main engine cutoff. After that, you have to carry extra RCS propellant to settle the liquids in order to get them out of the ET.

There are good technical reasons why NASA is doing what it is doing with Centaur. As for the question of NASA's position on innovation, the Shuttle itself is proof of a flexible attitude. And in any case, choosing the Dry Centaur concept would only have resulted in an expensive new development effort and the shifting around, not elimination, of bureaucracy.

DONALD E. PREVETT

Houston, TX

The author replies:

I'm a science writer, not a Shuttle engineer. I do wonder, though, if the NASA people have seriously looked at Dry Centaur. To take Mr. Prevett's points in turn:

1. You don't need much extra propellant in the External Tank (ET). For every pound you can save in the shuttle bay, you get between .95 and .98 pounds of ET propellent you didn't have to burn. You're already carrying nearly enough fuel to fill Centaur, but burning it to launch safety equipment and piping.

The nice part is that it's all free.

2. If you launch Centaur dry, you don't need any dump plumbing for Return To Launch Site (RTLS) abort. If Shuttle makes it to orbit but Centaur fails to deploy, Rockwell's studies show that the same 4″ upload lines that fill Shuttle can be used to dump the fuel through Space Shuttle Main Engines (SSME). After all, you're in no great hurry.

Regarding those line sizes: When I wrote the Dry Centaur piece, the design plan was 17″ dump lines. Nobody liked that very much, and there were studies of how to combine 5″ dump lines with shaping the Shuttle launch profile. This seems to be the present plan; Mr. Prevett would know better than I would. I do understand there are problems with dumping within the time limits if you use 5″ lines.

3. The Rockwell study (PD82–1A, February 1982, Space Operations Center, "Shuttle Interaction Study Extension, Final Review," NASA Document Number NAS9–16153) shows two 4″ lines from the Space Shuttle Main Engine (SSME) to a tank in the cargo bay. They do *not* go all the way to the ET. A 10 kw. pump is required for the oxygen; residual pressure is sufficient to move the hydrogen. The 10-kw pump operates at a time when power is available.

The whole point of the Dry Centaur exercise is to fill Centaur at high altitude. Above 100,000 feet hydrogen and oxygen do not form explosive mixtures;

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thus you don't have to take so many precautions lest you blow the doors off the Shuttle. This results in much saving of safety equipment weight.

Precisely how much fuel is required for ullage (settling the LOH and LOX in their tanks so that they can be pumped into Centaur) is not known. It's clear that it doesn't take a full gravity. The Rockwell document looks at three possible mass flows over a period of 18 minutes (the time required to fill Centaur). At the highest rate, 414 lbs./minute, Dry Centaur still looks possible. At the lowest rate, 11.5 lbs./min., the Dry Centaur savings are spectacular.

I've asked several astronauts if they want to fly Wet Centaur. I got interesting answers. Fred Haise (of Apollo 13) said, "If there were a pressing national need, I'd fly it once." Other pilots have given me similar answers. Nobody really and truly wants to fly a Shuttle with a main bay full of LOH, LOX, and plumbing.

The studies I've seen show we may not have to do it that way, and I've yet to see anything that convinces me otherwise. What bothers me is that the people dealing with the problem don't seem seriously to have considered the alternatives.

JERRY POURNELLE, PH.D.

Dear Mr. Schmidt:

As an adventure story, *Manna* is at best pedestrian and imitative, but the one aspect of it deserving of comment I find most disturbing. The General, a most sympathetic character portrayed as the wise leader of a battle to maintain freedom, and used by G. Harry Stine (under his pseudonym, Lee Correy) as an authorial voice to explain the historical background of his novel, uses the long-discredited and historically dangerous "international bankers' conspiracy" as the foundation of the political and economic conditions against which the heroes are struggling. Since the only examples of this conspiracy offered are the Rothschild family, Stine has proceeded one dangerous step further by innuendo, and suggests an "international Jewish bankers' conspiracy." The scandalous roots and horrifying consequences of such views need no elaboration here, but the inclusion of such innuendo in an *Analog* story ought not to pass without comment or protest.

While the relationships between large, private economic interests and the political power of various governments over time have been both complex and unsavory, Mr. Stine, like so many who gravitate to conspiracy theories, has oversimplified matters too much, even too much to provide a background for his story. The Rothschilds hardly invented large-scale banking or the dealings between bankers and governments. The Hanseatic League of North Germany, the House of Fugger (which was worth the equivalent of $1 billion in 1500 and which financed the exploratory voyages of Magellan, Vespucci, and Cabot), and the Italian Medici family all preceded the Rothschilds by a considerable margin, and were far more powerful than they for a long time. If the Rothschilds are simply the most familiar of the old European banking families, it is *only* because they are Jewish and have long been singled out for attack by those seeking to blame Jews for the ills of the world.

One would have expected a writer of Mr. Stine's experience to be aware of and sensitive to this historical situation and to have avoided unnecessary innuendo in his story. I can only infer that the gratuitous selection of a Jewish banking family represents (at the very least) a severe lack of concern for the

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possible influences and consequences of those ideas and their publication, on the part of both writer and editor. Once the name of Rothschild is raised in the story, the treatment of their economic power and influence in France under the Nazis is appallingly casual. This too suggests that writer and editor alike were too little concerned with the racist innuendo which they are perpetuating, regardless of intention.

As an historian of science fiction (my biography of John Campbell is forthcoming from Borgo Press and my history of *ASF* will appear in the Greenwood Press *Handbook of Science Fiction Magazines*, Marshall Tymn and Mike Ashley, eds.), I am aware that *Manna* is not without precedent insofar as its hostility to large concentrations of economic power and the modern system of banks and corporations goes. "Final Blackout" and "The End is Not Yet" by L. Ron Hubbard, and a good many of Robert Heinlein's stories, spring most readily to mind. However, I have not previously encountered a story using this theme in which anti-semitic innuendo was so apparent, at least not in *ASF*. I might point out that Heinlein and Poul Anderson have written classic stories dealing most explicitly with the same issues as Stine, without seeming offensive in this manner.

ALBERT I. BERGER, PH.D.
Ossining, NY

Since you are the only person who has claimed to see this "innuendo," and I found your claim as surprising and shocking as you found the point in the story, I think you're reading far more into it than you should or can justify. The Rothschilds were mentioned because they are the most familiar example; nothing was said or implied about their religion. If the story had mentioned John F. Kennedy in a context you didn't like, would you interpret that as an attack on Catholicism? For my thoughts on this sort of thing, please see my August 1979 editorial, "Equal Rights for Dumb Blondes."

Dear Sir:

It is obviously too late for me to participate in the AnLab survey, and that is exactly the point of my letter. I have only just received my December and January issues. I would like to have a chance to express my opinions, but with the end-year copies being caught up in the Christmas mail this is not likely to happen. Would it be possible to extend the deadline next year to give overseas subscribers a chance?

Whilst I'm anyway writing, I would like to mention two other points. Firstly, the index lists Marc Stiegler's "Evolution of Entropic Error in a Closed Conservative System" as a fact article (a). I most sincerely hope that is an error!

Secondly, in order to include serials in the survey, could they not be "judged" on a biannual basis? This year's AnLab would include '82 and '83 serials, next year '83 to '84 serials and so on, so that each serial appears two years in a row? That way, I can still cast a vote for Andrew Offutt and Richard Lyon's superb *Rails Across the Galaxy*.

Please consider my suggestions and try to remember that the world does not end at the Canadian border.

IB MARTA SANDBERG
Newman, W.A., Australia

I sympathize with the problem, but I'm afraid there's not much we can do about it. Even stretching deadlines a bit more than is usually possible, our existing schedule barely lets us get the results into the June issue. That's already later than I'd like, and I don't think we can push it any farther. ■

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Conference on Frontiers in Education at Worcester, Mass. Info: FIE 83, W.R. Grogan, WPI, Worcester MA 01609.

24–26 October
ACM Annual Conference at N.Y.C. Info: Thomas D'Auria, ACM83 Conference Chairman, City of New York, Computer Services Center, 111 Eighth Avenue, New York NY 10011.

7–11 November
Compsac 83, IEEE Computer Society 7th International Conference on Computer Software and Applications at Chicago, Ill. Info: Compsac 83, Box 639, Silver Spring MD 20901. 301-589-8142. TWX 7108250437 IEEECOMPSO.

11–13 November
INCOGNICON (SF conference) at Ottawa, Ontario. Guest of Honour—Andrew Offutt; Fan Guest of Honour—M.K. Longcor. Registration—US$10 in advance, higher at the door. Info: Incognicon, Box 15776, Station F, Ottawa, Ontario K2C 3S7 CANADA.

12 November
APRICON 6 at Ferris Booth Hall, Columbia University, N.Y.C. Lectures, films, trivia quiz, Japanese animation, etc. Registration—$3 until 31 October, $4 at the door. Info: Barnard-Columbia SF Society, 317 Ferris Booth Hall, Columbia University, New York NY 10027.

12 November
Fantasy and SF art show at U. of Maryland-College Park. Artwork is invited; interested artists should send SASE with descriptions of their work to F & SF Course, P.O. Box 2185, Washington DC 20013 or call (202) 659-2213.

18–20 November
CONCENTRIC (SF/fantasy/gaming convention) at Holiday Inn West, Columbia, Mo. Guest of Honor—Jack Chalker; Fan Guest of Honor—Pat Killough. $15 at the door. Info: Concentric, P.O. Box 7514, Columbia MO 65205.

20–23 November
General meeting of the American Physical Society at San Francisco, Calif. Info: A.P.S., 335 East 45th Street, New York, NY 10017.

28–30 November
NECRONOMI-CON 1983 (Tampa-area SF conference) at Holiday Inn—Downtown Tampa, Fla. Guests of Honor—Piers Anthony and Robert Adams; Fan Guests of Honor—Bill Ritch and Kenny Mitchroney. The usual plus alien cooking lessons, trivia *quizzes, etc. Registration—$15 at the door* (if available). Info: Necronomi-con, P.O. Box 2076, Riverview FL 33569.

30 August–3 September 1984
LA CON II (42nd World Science Fiction Convention) at Anaheim Convention Center, Los Angeles, Calif. Guest of Honor—Gordon R. Dickson; Fan Guest of Honor—Dick Eney; TMs—Robert Bloch & Jerry Pournelle. Registration—$40 until 31 December 1983, more later and at the door. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: LA Con II, Box 8442, Van Nuys CA 91409.

—Anthony Lewis

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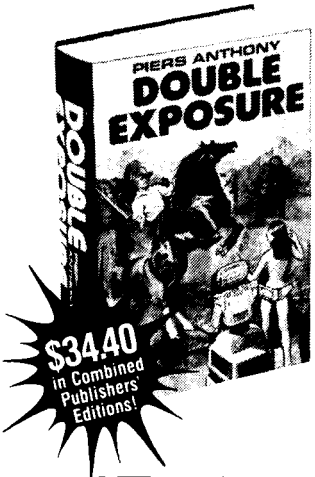

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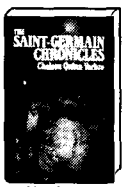

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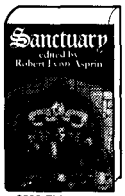

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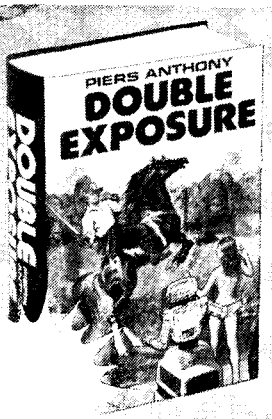

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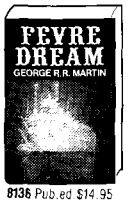

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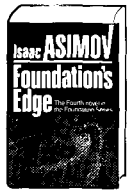

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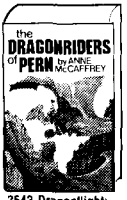

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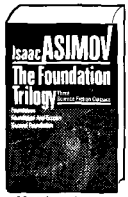

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